KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, DEC. 5, 1884.

Contents of No. 162.

	PAGE
The Chemistry of Cookery. XLVIII. By W. Mattieu Williams	455
Chats about Geometrical Measurement. (*Illus.*) By R. A. Proctor	456
Sunspots, Temperature, and After-glow	458
The Entomology of a Pond. By E. A. Butler	458
The World's First Meridian. By Richard A. Proctor	460
Our Scientific Industries: Gas. By W. Slingo	462
The Tricycle in 1884	463
Earth's Shape and Motions. (*Illus.*)	464
Gorham's Pupil Photometer. (*Illus.*)	465
Standard of Politics in America	466
Chapters on Modern Domestic Economy: The Dwelling-House	466
Reviews	467
Face of the Sky. By F.R.A.S.	469
Crows *versus* Woodchuck	469
Our Inventors' Column	470
Correspondence: Doctoring Wine Statistics of Barataria—Noah's Rainbow, &c.	471
Our Whist Column	473
Our Chess Column	474

THE CHEMISTRY OF COOKERY.

By W. Mattieu Williams.

XLVIII.—THE WEAR AND TEAR OF THE BODY.

IN the course of these papers I have repeatedly spoken of the nitrogenous and non-nitrogenous constituents of food, assuming that the nitrogenous are the most nutritious, are the plastic or flesh-building materials; and that the non-nitrogenous materials cannot build up flesh or bone or nervous matter, can only supply the material of fat, and by their combustion maintain the animal heat.

In doing so I have been treading on loose ground—I may say, on a scientific quicksand. When I first taught practical physiology to children in Edinburgh, many years ago, this part of the subject was much easier to teach than now. The simple and elegant theory of Liebig was then generally accepted, and appeared quite sound.

According to this, every muscular effort is performed at the expense of muscular tissue; every mental effort, at the expense of cerebral tissue; and so on with all the forces of life. This consumption or degradation of tissue demands continual supplies of food for its renewal, and as all the working organs of the animal are composed of nitrogenous tissue, it is clearly necessary, according to this, that we should be supplied with nitrogenous food to renew them, seeing that the nitrogen of the air cannot be assimilated by animals at all.

But besides doing mechanical and mental work, the animal body is continually giving out heat, and its temperature must be maintained. Food is also demanded for this, and the non-nitrogenous food is the most readily combustible, especially the hydro-carbons, or fats; the carbo-hydrates—starch, sugar, &c.—also, but in lower degree. These, then, were described as fuel food, or heat-producers.

This view is strongly confirmed by a multitude of familiar facts. Men, horses, and other animals cannot do continuous hard work without a supply of nitrogenous food; the harder the work the more they require, and the greater becomes their craving for it. On the other hand, when such food is eaten in large quantities by idle people, they become victims of inflammatory disease, or their health otherwise suffers, according, probably, to whether they assimilate or reject it.

Man is a cosmopolitan as well as an omnivorous animal, and the variations of his natural demand for food in different climates affords very direct support to Liebig's theory. Enormous quantities of hydro-carbon, in the form of fat, is consumed by the Esquimaux and by Europeans when they winter in the Arctic regions. They cannot live there without it. In hot climates *some* fuel food is required, and the milder form of carbo-hydrates is chosen, and found to be most suitable; rice, which is mainly composed of starch, is an example. Sugar, also. Offer an Esquimaux a tallow candle and a rice pudding, he will reject the latter, and eat the former with great relish.

A multitude of other facts might be stated, all supporting Liebig's theory.

There is one that just occurs to me as I write, which I will state, as it appears to have been hitherto unnoticed. Some organs which act in such wise that we can *see* their mode of action are visibly disintegrated and consumed by their own activity, and may be seen to demand the perpetual renewal described by Liebig. There are certain glands of cellular structure which cast off their terminal cells containing the fluid they secrete; do their work by giving up their own structural substance at their peripheral working surface.

Where, then, is the quicksand? It is here. If muscular and mental work were done at the expense of the nitrogenous muscular and cerebral tissues, the quantity of nitrogen excreted should vary with the amount of work done. This was formerly stated to be the case without hesitation, as the following passage from Carpenter's "Manual of Physiology" (3rd Edition, 1856, page 256) shows: "Every action of the nervous and muscular systems involves the death and decay of a certain amount of the living tissue—as is indicated by the appearance of the products of that decay in the excretions."

More recent experiments by Fick and Wislicenus, Parkes, Houghton, Ranke, Voit, Flint, and others contradict this by showing that the waste nitrogen varies with the quantity of nitrogenous food that is eaten, but not with the muscular work done. For the details of these experiments I must refer the reader to standard *modern* physiological treatises, as a description of them would carry me too far away from my immediate subject. (Dr. Pavy's "Treatise on Food" has an introductory chapter on "The Dynamic Relations of Food," in which this subject is clearly treated in sufficient detail for popular reading.)

It is quite the fashion now to rely upon these later experiments; but, for my own part, I am by no means satisfied with them—and for this reason, that the perspiration from the skin and the vapour from the lungs were not examined. It is just these which are greatly increased by exercise, and their quantity is very large, especially those from the skin, which are threefold, viz., the insensible perspiration, which is transpired by the skin as invisible vapour, the sweat, which is liquid, and the solid particles of exuded cuticle.

Lavoisier and Seguin long ago made very laborious experiments upon themselves in order to determine the amount of the insensible perspiration. Seguin enclosed himself in a bag of glazed taffeta, which was tied over him with no other opening than a hole corresponding to his mouth; the edges of this hole were glued to his lips with a mixture of turpentine and pitch. He carefully weighed himself and the bag before and after his enclosure therein. His own loss of weight being partly from the lungs and partly from the skin, the amount gained by the bag represented the quantity of the latter; the difference between

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this and the loss of his own weight gave the amount exhaled from the lungs.

He thus found that the largest quantity of *insensible* exhalation from the lungs and skin together amounted to 3½ ounces per hour, or 5¼ lb. per day. The smallest quantity was 1 lb. 14 oz., and the mean was 3 lb. 11 oz. Three-fourths of this was cutaneous.

These figures only show the quantity of insensible perspiration during repose. Valentin found that his hourly loss by cutaneous exhalation while sitting amounted to 32·8 grammes, or rather less than 1¼ ounce. On taking exercise, with an empty stomach, in the sun, the hourly loss increased to 89·3 grammes, or nearly three times as much. After a meal followed by violent exercise, with the temperature of the air at 72° F., it amounted to 132·7 grammes, or nearly 4½ times as much as during repose. A robust man, taking violent exercise in hot weather, may give off as much as 5 lb. in an hour.

The third excretion from the skin, the epithelial or superficial scales of the epidermis, is small in weight, but it is solid, and of similar composition to gelatine. It should be understood that this increases largely with exercise. The practice of sponging and "rubbing down" of athletes removes the excess; but I am not aware of any attempt that has been made to determine the quantity thus removed.

Does the skin excrete nitrogenous matter that may be, like urea, a product of the degradation or destruction of muscular tissue?

The following passage from Lehmann's "Physiological Chemistry," Vol. ii., 389, shows that the skin picks up plenty of nitrogen from somewhere:—"It has been shown by the experiments of Milly, Jurine, Ingenhouss, Spallanzani, Abernethy, Barruel, and Collard di Martigny, that *gases*, and especially *carbonic acid* and *nitrogen*, are likewise exhaled with the liquid secretion of the sudiparious glands. According to the last-named experimentalist, the ratio between these two gases is very variable; thus, in the gas developed after vegetable food, there is a preponderance of carbonic acid, and after animal food, there is an excess of nitrogen. Abernethy found that on an average the collective gas contained rather more than two-thirds of carbonic acid and rather less than one-third of nitrogen." But it appears that less gas is exhaled when there is much liquid perspiration.

Lehmann's summary of the experiments of Abernethy, Brunner, and Valentin (Vol. ii., page 391), gives the amount of hourly exudation, under ordinary circumstances, as 50·71 grammes of water, 0·25 of a gramme of carbon, and 0·92 of a gramme of nitrogen. This amounts to 21½ grammes of nitrogen per day in the *insensible* perspiration; three-quarters of an ounce avoirdupois, or as much nitrogen as is contained in 4½ oz. of dried muscle, or more than 1 lb. of natural living muscle.

That the liquid perspiration contains compounds of nitrogen, and just such compounds as would result from the degradation of nitrogenous tissue, is unquestionable. As Lehmann says (Vol. ii., page 389) "the sweat very easily decomposes, and gives rise to the secondary formation of ammonia." Simon and Berzelius found salts of ammonia in the sweat, that the ammonia is combined both with hydrochloric acid and with organic acids; that it probably exists as carbonate of ammonia in alkaline sweat.

The existence of urea in sweat appears to be uncertain; some chemists assert its presence, others deny it. Favre and Schottin, for example, who have both studied the subject very carefully, are at direct variance. I suspect that both are right, as its presence or absence is variable, and appears to depend on the condition of the subject of the experiment.

Favre describes a special nitrogenous acid which he discovered in sweat, and names it *hydrotic* or *sudoric acid*. Its composition corresponds, according to his analysis, to the formula $C_{10}H_8NO_{13}$.

I have summarised these facts, as they show clearly enough that conclusions based on an examination of the quantity of nitrogen excreted by the kidneys alone (and such is the sole basis of the modern theories), are of little or no value in determining whether or not muscular work is accompanied with degradation of muscular tissue. The well-known fact that the total quantity of excretory work done by the skin increases with muscular work, while that from the kidneys rather diminishes, indicates in the plainest possible manner that an examination of the skin secretion should be primary in connection with this question.

Seeing that this has been entirely neglected, I am justified in expressing, very plainly and positively, my opinion of the worthlessness of all the modern research upon which the alleged refutation of Liebig's theory of the destruction and renewal of living tissue in the performance of vital work is based, and my rejection of the modern alternative hypothesis concerning the manner in which food supplies the material demanded for muscular and mental work.

I may be accused of rashness and presumption in thus standing almost, if not quite, alone in opposition to the overwhelming current of modern scientific progress. Such, however, is not the case. It is modern scientific *fashion*, rather than scientific *progress*, that I oppose. We have too much of this millinery spirit in the scientific world just now; too much eagerness to run after "the last thing out," and assume, with undue readiness, that the "latest researches" are of course, the best—especially where fashionable physicians are concerned.

CHATS ABOUT GEOMETRICAL MEASUREMENT.

By Richard A. Proctor.

(*Continued from p.* 417.)

A. We come now to the measurement of areas bounded by curves. Does this involve a new application of the principle you have indicated, or are new principles involved?

M. No new principles are involved. In all problems of geometrical measurement you have to determine an amount, and you must do it by dividing up the quantity you wish to measure into parts which you can deal with simply and add together conveniently,—

A. But that sounds like a truism.

M. It is one. But you spoke too soon. As a matter of fact, you cannot divide curved arcs or areas bounded by such curves, or curved surfaces, or volumes, into such parts,—that is where the difficulty comes in. You must adopt some device by which though you necessarily leave out portions of the quantity you are dealing with, you may yet be able to show that those portions can be neglected, *because* they may be made less than any quantity, however small, which can be named.

A. Give me an example,—something concrete.

M. An area bounded by a curved line will be just what you want:—Suppose O M X, O A Y, two lines at right angles to each other; A P B a curved arc; B M perp. to O X, and that the area you wish to determine is that enclosed between the straight lines O A, O M, M B, and

the curved arc A P B. You can divide this area by a series of such parallels as are shown in Fig. 1,—say equidistant parallels,—into spaces such as L P Q N, in which, since P Q is curved, you would seem to have the same difficulty to deal with as in the original figure. But if you complete the rectangles N l, L n, you see that the area P Q l is very small compared with either of these rectangles; and you can easily see that if the strip P N is made very narrow indeed the area P Q l might be neglected, compared with Q L or P N, either of which rectangles you might take, instead of P Q L, without appreciable error. Doing this for the whole area you have rectangles to deal with, instead of surfaces bounded by a curved line, or by curved lines.

A. Yes!—but—though you thus make each little area as P Q l very small, you make the number of such areas very large, and a very large number of very small things may make an appreciable total.

M. True; but if each such part as P Q l is very small compared with the total area P Q N L, must not the sum of all such parts be very small compared with the sum of all such areas?—or in other words must not all the little areas like P l Q, taken together, be insignificant compared with the area A B M O?

A. I cannot say I quite see this.

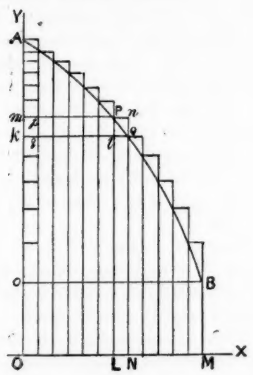


Fig. 1.

M. Suppose P l Q a millionth part of P Q N L, and none of the other small areas like P l Q to be *more* than a millionth part of the area like P Q N L of which it is a portion. Would not all such areas as P l Q, together, be less than a millionth part of the area A B M O?

A. Yes. I see that. But it does not seem possible to prove that you can so arrange matters that such areas as P l Q may be any given very small proportion of such areas as P Q N L.

M. Why, regarding P for the moment as fixed, may not Q be brought so close up to P that P l may be as small as we please, and therefore the rectangle ln bear as small a ratio as we please to the rectangle Q L. If this is done, then assuredly the area P l Q will bear a smaller ratio still to Q L. Suppose you wanted P l to have some given value; well, all you have to do is to measure off P l of that value, and from l to draw l Q parallel to O X; then you have your points P, Q, from which to draw parallel perpendiculars to O X.

A. The proof, I see, depends on making the parallels of Fig. 1 as close together as possible.

M. Quite so. And we may easily prove the soundness of the conclusion we have just reached. From P Q draw P p m, Q q k, perpendicular to A O, and let a series of such perpendiculars be drawn from all such points as P, Q, &c., B o being the last of them. Then if the parallels are equidistant the rectangle ln is equal to the rectangle pk, and the like for all such rectangles as ln; giving, for the sum of them all, the rectangle oa, and therefore for the sum of all such areas as P l Q an area less than the rectangle oa. But oa may be made as small as we please by sufficiently increasing the number of the parallels. Even if the parallels are not equidistant, the proof remains good, so long as the greatest distance between the parallels may be made eventually as small as we please. For obviously the rectangle we then get instead of ao may also be made less than any area which can be assigned.

A. But now, all this is very indefinite. What *is* the curve A P B? and how can such a series of parallels be drawn as your argument requires?

M. There is no more occasion for actually drawing such parallels, than for making our straight lines, circles, &c., in ordinary geometry, be perfectly accordant with the definitions.

A. But will you not give an instance of the actual application of this method?

M. Certainly. Let us take my old friend the cycloid, which affords more examples of various ways of measuring areas than any curve I know of. I will take one of the simplest proofs of the area of the cycloid from among nearly a score which I have given in my "Geometry of Cycloids."

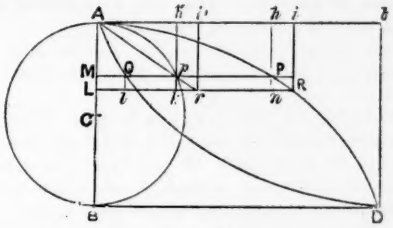


Fig. 2.

Let A P D, Fig. 2, be a half cycloid, A B its axis, A p B half the rolling circle. We want to find the area A P D B. Complete the rectangle A B D b, whose area (since B D is equal to arc A p B) is equal to twice that of the rolling circle. Let A Q D be an equal half cycloid having D b as axis. Then if m Q p P be drawn parallel to A b we know that

$$\text{M P} = \text{arc A}p + \text{M}p$$
$$\text{and M Q} = \text{arc A}p - \text{M}p$$

Hence, subtracting, Q P = 2 M p

Therefore, if we draw a parallel L l k n R very near indeed to M P, as in Fig. 2,

$$\text{rectangle Q}n = 2 \text{ rect. M}k.$$

Imagine an immense number of such parallels athwart the semicircle and the cycloids. The sum of all the rectangles in the space A P D Q is equal to twice the sum of all the rectangles in the semicircle Ap B. Wherefore eventually (when the number of parallels becomes indefinitely large) we have

$$\text{Area A P D Q} = 2 \text{ semicircle A}p\text{ B} \quad \text{(i.)}$$

But (since rect. B6 = 2 rolling circle),

$$\text{A Q D B} + \text{A P D}b = 2 \text{ semicircle A}p\text{ B}$$

or,

$$\text{Area A Q D B} = \text{semicircle A}p\text{ B} \quad \text{(ii.)}$$

∴ adding (i.) and (ii.),

$$\text{Area A P D B} = 3 \text{ semicircle A}p\text{ B}$$

or, the *area of a cycloid is equal to thrice the area of its generating circle.*

A. That is very curious. Let me see,—I want another figure to make the matter clear to me, and to see some of its consequences. I take the oddly-shaped space A Q D P, and set the rolling circle of either cycloid midway upon it,

as at L a M b, so that L c M its horizontal diameter meets A Q D, D P A in L and M. Then the circle a L a M b is equal to the figure A P D L. I join A D (passing, obviously, through c). Then A P D Q is divided into two equal parts, each equal to a semicircle F A G or F b G. The spaces A K L, M N D, are equal; and each is obviously equal to either of the equal spaces K a M, L b N. Again, any space like A P Q is equal to the corresponding segment

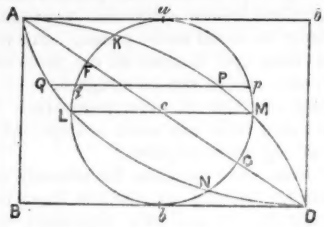


Fig. 3.

a q p,—Q q P p being parallel to A b, B D. Also A K q Q is equal to a K P p; and Q q L is equal to P p M. What a number of odd relations, each one of which seems unprovable directly, seem to come in!

M. You would find each one of these relations readily demonstrable, independently of the general result. Considering such corollaries one often recognises simpler proofs of the main proposition. You will find several examples of this in my "Geometry of Cycloids."

A. I see that, reverting to Fig. 2, the area A P D b must be equal to the semicircle A p B. Can this be proved directly?

M. It can; but I will leave this to you as an exercise. Begin thus,—From P, R, draw P h, R i perp. to A b. Then, noting that by a property of the cycloid the tangent at P or R has ultimately (when these points come near enough together) a direction parallel to A p, show that the rectangle P i is equal to the rectangle L p. This you will find easy by making a rectangle corresponding to P i, in all respects, as shown at p i': this rectangle and L p are complementary, and therefore equal. The rest should be easy. But, should you fail, note that the next example, which will relate to the area of a parabolic segment, will show the method fully.

(To be continued.)

SUN-SPOTS, TEMPERATURE, AND THE AFTERGLOW.

IN an excerpt from his "Memoirs of Life and Work," Dr. C. J. B. Williams, F.R.S., has published an account of a series of observations made at Cannes which possess sufficient interest to render some notice of them desirable. After speaking of the beginning of 1883 as a period of sun-spot maximum, he goes on to say:—"But on Feb. 28, 1883, I was surprised to find the sun without a spot. On March 3 I observed again, and still found no spot. The next day began a fall of temperature of 6° Fahr., with a high wind from the north-east, which continued till March 7, when there came on a heavy snowstorm, covering the ground to the depth of eight inches, and causing great destruction in my garden, bearing down and breaking many valuable trees and shrubs. This was followed by a fall of temperature to five, six, and seven degrees below freezing, even in my sheltered situation: in more exposed places it fell four and five degrees lower. Such cold had not visited Cannes before for sixty years; and it was the more remarkable as the previous part of the winter had been quite mild, only two or three times reaching the freezing-point. This severe weather lasted till the middle of March, when the sun-spots began to re-appear, and the average temperature to rise in proportion." A similar fall in temperature, we may note, occurred in the month of December, at a time when the solar disc was free from signs of disturbance.

In order, however, to prove that this quiescence of the sun's surface, and a merely local fall in terrestrial temperature, stood in the relation of cause and effect, it would be very desirable, if possible, to collect data as to the meteorological conditions at Cannes during the years 1870 (maximum period), 1878 (minimum), and so on; and to ascertain how far temperature was simultaneously affected elsewhere.

Another statement of Dr. Williams's will certainly possess the charm of novelty. We refer to his announcement that Mr. J. F. Campbell, of Islay, has invented what he calls a "Pictorial Thermometer, which marks degrees of heat by certain changes of colour in Prussian blue, Scheele's green, and other pigments." Assuming (in the absence of any description) the indications of this instrument to be trustworthy, it is interesting to read:—"1. That an area in a solar image, focussed on a sensitive screen, in the proportion of $\frac{2}{3}$, is much hotter than the rest, as proved by colours which record temperatures. 2. It was clearly proved that sun-spots, while within the hot area, radiate much more heat than the rest of the area. Spots were seen to draw hot traces repeatedly. 3. The same spot, when outside of that hotter area, radiates less heat than the rest of the visible sun. Mr. Campbell further informs me that he actually measured the heat of the sun on the spotless day, December 5, which I have recorded, and that it did not rise higher than 1100° Fahr.; while on many previous days, with many spots, it reached 1600° and upwards."

Here again, however, some check on or control of the observations recorded would seem desirable. Dr. Williams' observations of the afterglow differ in no material respect from those of hundreds of others which have been made all over the world. In opposition, however, to what he excellently describes as the "sensational expansion of Mr. Meldrum's hypothesis of volcanic dust," which appeared in the *Times* at the beginning of last December, he makes the infinitely more rational and scientific suggestion that it is ice-dust in the higher regions of the atmosphere which has been the chief operative agent in the production of the exquisite phenomena with which we are now familiar. It is needless to point out that this, if accepted as a *vera causa*, would explain the apparition of the afterglow at the beginning of 1883, six months before the Krakatoa eruption ever took place at all! (*Vide* KNOWLEDGE, Vol. V., p. 418.)

THE ENTOMOLOGY OF A POND.

By E. A. Butler.

ABOVE THE SURFACE (*continued*).

THE transition from the obscure, sluggish, and inoffensive stone-flies and alder-flies to the brilliant, active, and rapacious dragon-flies, which are the most highly predaceous of all the insect denizens of the air, is, indeed, a passage from one extreme to the other, so far as habits are concerned, and well illustrates the heterogeneous composition of the order Neuroptera, of which the dragon-flies are usually regarded as forming the section Odonata. We have already seen how these creatures comport themselves

in their early days, and we left them airing their newly-acquired wings just after exclusion from the pupa or nymph-case. In general appearance a dragon-fly is probably as well known and as easily recognised as any insect. The glistening aspect of the four ample wings, the length and slenderness of body, the brilliancy of colour, the vigour of flight, are all characteristics which even careless observers must have noticed again and again, and which, once seen, are not easily forgotten.

We have about fifty British species of these insects. Some of them are popularly called Horse-stingers, a sobriquet which, suggested no doubt by the long, narrow body and bold and ferocious aspect of the insects, and apparently confirmed by their writhing contortions when seized, and their attempts to reach with their tails the hand that seizes them, is nevertheless an instance of most absurd misnaming. They have no power whatever of stinging, any more than any other of the Neuroptera, the members of which order are, so far as any *such* power is concerned, the most harmless set of insects imaginable. The body is very generally narrow and cylindrical, but not always so; there are a few instances in which it is broad and somewhat flattened, and at the same time proportionately shorter than usual. It is at its broadest in the genus *Platetrum*, the single species of which—*P. depressum*—with its pale blue (male) or yellow (female) body, is one of the most familiar of the whole group. Though so long, the body does not consist of a larger number of segments than usually compose this part of an insect; but, just as there is the same number of vertebræ in the long neck of the giraffe as in the short one of the elephant, so the linear extension of the body of the dragon-fly is produced, not by a multiplication of the number of the joints, but by their individual elongation. To so great an extent is this carried that in one exotic species we find a body of 6 in. long, though the wings are only of ordinary size.

No doubt these long bodies are serviceable in guiding the creatures in their flight, and they also render possible the deposition of the eggs in suitable positions at some distance below the surface, without the disagreeable expedient of a dive on the part of the mother, though, in some cases, maternal solicitude does not hesitate even to run this risk, if the supreme end cannot otherwise be attained. Westwood says that he has also seen the females beat their tails upon the surface of the water with rapid succession, till the eggs form a mass like a bunch of grapes; and another author records having seen them beating the sand close by the edge of the water, an operation which, it has been suggested, may have for its object rather the covering of eggs already laid, than the actual laying of them.

The thorax has a great vertical diameter, and thereby acquires a hunchbacked appearance; this is, of course, necessary for the proper lodgment of the powerful muscles that move the wings. The wings themselves are remarkable for the enormous number of reticulations with which they are covered. There are a few main nervures branching out from the base of the wing, and running more or less longitudinally, and the spaces between these are divided into a vast number of minute four-, five-, or six-sided spaces, which are smallest at the tip and hinder edge. The number of meshes is smallest, and the individual meshes largest, in the smallest and most delicate and slender species, the Agrionidæ, while the Calopterygidæ—*i.e.*, those whose wings are dark metallic blue or green—have the greatest number of reticulations, extending to some 1,500 or more on each wing.

The head is differently shaped in different families, but the huge masses of compound eyes almost always occupy a very large proportion of its surface. These insects are the keenest possible of hunters, relentlessly pursuing to the death any creature on whose tender body they have set their gastronomic affections, and hence their remarkably good eyesight, which, by giving them a wide range of vision, enables them easily to descry their prey in the first instance, and also to follow it in all the intricacies of its movements, dodging it from place to place till it is hunted down. There are few more beautiful objects in the whole range of the insect world than the eye of a *living* dragon-fly, such as that which is often seen hawking about over ponds or down the neighbouring woody glades, the great *Æchna cyanea*, one of the largest and commonest of our native species, with clear wings, and body prettily spotted with green and blue on a black ground. Apart from the mere glistening of the surface, which is in itself no slight adornment, there is a marvellous play of colours in the interior as the light falls at different angles that altogether baffles description, and must be seen to be appreciated; unfortunately, no trace of these beauties can be preserved after death, and the eyes become little more than opaque brown masses, retaining only the most shadowy relics of their former brilliancy. The nature of the exterior, however, can be seen better in the dead than in the living insect. Very little magnification is necessary to show that the surface is not uniform, but is broken up into an enormous number of extremely minute spaces, which greater magnification shows to be of hexagonal form. The chitinous skin that covers the whole body of the insect is continued over the eye as a transparent layer, or—to use the terminology of vertebrate anatomy—cornea, and it is this that is divided into hexagonal facets, each one of which is generally somewhat convex on both its external and internal surfaces, and contains in and beneath itself all that is necessary to produce complete vision, and this is what is meant when it is said that an insect's eye is compound. But it no more follows from this arrangement that an insect is gifted with multiple vision than that we ourselves with our two eyes see double. The eyes in our present insects form two rounded surfaces, which occupy the whole of the sides of the head, and often even meet above on the middle of the crown, thus extending all round the head from one angle of the mouth to the other. From that part of the nervous system which, in an insect, to some extent does duty for a brain, passes the optic nerve on each side into the centre of the rounded space thus enclosed, and there expands into a broad knob, from which delicate threads, surrounded with dark colouring matter, and ending in inverted cones of a highly-refracting medium, pass to the inner edge of the facetted parts of the cornea. The latter act as lenses, and produce the necessary convergence of the rays of light, and thus at every point of this vast surface light can be received and utilised for the production of vision. What the exact nature of the image produced, what the degree of accuracy with which it is perceived, who shall attempt authoritatively to decide? though it can scarcely be doubted that vision is of a high order, else the insect would hardly be able so readily and speedily to adapt its own movements to those of the quarry it pursues.

In the centre of the head, at the inner edge of the eye-masses, are two apparently bristle-like, but really jointed, appendages, which are all the insect possesses in the way of antennæ, and they are so inconspicuous as easily to escape notice altogether. Just below these, the centre of the head bulges out into a rounded protuberance, below which again are placed the organs of the mouth. These are very complicated; two flaps open above and below, and then the jaws proper are seen working laterally. They are armed with sharp-pointed and powerful teeth, which easily

make havoc with the tissues of any insect that once gets within range of their action. The head is attached to the thorax by a very slender junction, and can, therefore, to some extent, be rotated thereon. When the insect is dead, this slenderness of attachment is a serious trouble to the collector, as his dried specimens manifest great readiness to part with their heads if at all rudely handled, or even if suddenly jarred, and he is then fain to collect the scattered members and gum them on again to the best of his ability. With equal, or even greater, readiness do the long slender bodies break off, and to guard against such a calamity, collectors have been recommended to run a fine piece of wire up the body while it is still fresh, and fix one end of it firmly in the thorax.

The male carries at the end of his abdomen some appendages which are, no doubt, partly responsible for the rustic theory of stinging, before alluded to; but they are simply clasping organs used by the gentleman for the abduction of his bride; for the courtship of these insects is conducted in a most peculiar way. With his claspers the lover seizes his betrothed by the neck, and the two then fly about in line, one behind the other, tandem-fashion, ever and anon dipping down towards the water till the lady's tail just touches the surface, then darting up again to resume their social flight.

When at rest, the wings are either spread out horizontally, as is the case with the larger and stouter-bodied kinds, or folded up over the back like those of a butterfly, as with the smaller and more slender-bodied ones. Amongst the larger species, an individual will often manifest a remarkable predilection for some particular twig as a place of rest, and notwithstanding repeated disturbances and dislodgments, will persistently return to that small perch, which seems to stand to it in place of home, though, so far as the ignorant human biped, who is evidently no connoisseur in such matters, can judge, there are plenty of others all round that seem equally well adapted for the purpose. Here, however, the creature sits, motionless as death, with its body placed at an angle with the twig, till the spirit of adventure again seizes it, when it suddenly darts off on its dashing career, ever seeking whom it may devour. Dragon-flies feed upon all sorts of insects that are found in such numbers in the neighbourhood of water, easily catching and devouring their prey on the wing. Their voracity is great, and their appetite not easily satisfied, and in consequence they are favoured with a degree of longevity greatly in excess of that of the rest of the Neuroptera. On the continent and in America prodigious swarms are sometimes observed migrating from one district to another. Each swarm consists of insects belonging to a single species, and so vast are their numbers that they sometimes take many hours to pass a given spot. Predaceous and courageous though they are, while thus migrating many fall victims to the attacks of insectivorous birds, which pursue them, nothing daunted by their numbers. A tropical species of bee-eater is said to line its nest with the wings of dragon-flies.

(*To be continued.*)

Erratum.—Column two, p. 443, "Table of Elements":—"Earth's *Daily* Motion in R.A., 34′·13″·5," should have been "Earth's *Hourly* Motion in R.A., 34′·13″·5."

It is proposed to establish a memorial to Dr. Rabbeth, who lost his life in attempting to save a child suffering from diphtheria, at the Royal Free Hospital, on Oct. 20. Any who may wish to express their practical appreciation of the brave and gallant conduct of this most worthy and lamented young member of a noble profession, can send their subscriptions to Drs. Cromon and Hayes, or to Mr. T. S. Short, at King's College.

THE WORLD'S FIRST MERIDIAN.

By Richard A. Proctor.

DESPITE the opposition of the French, Brazilian, and Haytian astronomers (a rather singular combination), the meridian of Greenwich has been adopted as the astronomical and geographical reference meridian for the world, and hereafter we may expect uniformity to prevail in maps and charts, in nautical almanacs, and in tables of reference alike for terrestrial and celestial computations. Of course, there will be no noteworthy change in the ordinary measurement of time in different countries or cities. At New York and Washington, for instance, where when it is noon in England it is only about seven in the morning, and only seven in the evening when it is midnight in England, they will not, because of the adoption of the Greenwich meridian, call it noon or midnight when the sun gives them so different a time of day. Ordinary or civil time will always be reckoned pretty nearly by the sun—not exactly, of course, for the simple reason that in that case every journey east or west would involve a change of clock time. Just as Ireland has a different time from England, not because of any native cantankerousness on either side of St. George's Channel, but because the sun gives different hours, so in the United States they must have their clocks and watches agreeing tolerably well with the sun, and so must have different local time from ours. In different sections of the States they will have, also, times differing by a full hour—earlier and earlier for more and more westward sections—an arrangement by which no place will have time much more than half-an-hour different from sun time. Half-an-hour is not a matter of any great importance, as we may know by the fact that no one in the business of life recognises the circumstance that sun time changes by more than half-an-hour in the course of each year in every part of the world. If we set a perfect clock or watch—that is, one steadily recording day after day 24 true hours of mean time, so that at the end of a hundred years or more it would be as near sun time as at the beginning—to show 12 noon when the sun was exactly south in February, then, tested by the sun, that clock would seem half-an-hour wrong at solar noon after about half a year had passed, which would *seem* to show that in a year it would be an hour wrong, and in six years would show six o'clock at 12, and in twelve years would show 12 noon for 12 midnight. Yet the discrepancy would be entirely due to a want of uniformity in the sun's motion, to which none except astronomers pay the slightest attention. In like manner, in the United States there are places where, judged by the sun (even when he is with the clock at Greenwich), the clocks seem half an hour too fast or too slow on the average all the time; yet business goes on undisturbed. The same arrangements will continue, now that the meridian of Greenwich is adopted as the reference meridian, which were in vogue before, except that possibly the American hour system may be brought into correspondence with Greenwich time instead of Washington time—so that, for instance, a traveller from England to New York or Washington would find his watch *exactly* instead of *nearly* five hours fast by New York or Washington time. In this way the whole world may one day be divided into hour zones, so that every change of time for a voyager travelling westwards would be made by putting back his watch exactly an hour, and every change for a voyager travelling eastwards would be made by putting his watch forward one hour exactly. Though, even then, at sea, the present system would have probably to be retained, by which each noon the approximate local noon is adopted.

In what, then, it may be asked, does the importance of the recent change consist? The astronomer and the geographer do not need to ask the question, knowing as they do the multitudinous inconveniences which arise from the use, in the astronomical computations, and the geographical charts made in different countries, of the longitudes of Greenwich, Vienna, Berlin, Paris, Washington, and so forth. I take up, for example, in the old time of the controversy about the transit of Venus, a treatise or paper written by Puiseux at Paris, or by Newcomb at Washington, and I find that before I can compare properly the results deduced or discussed by the French or American astronomer with my own, or with others dealt with by English astronomers, I must translate the French or American longitudes and times into Greenwich longitudes and times. Even in the case of a single treatise, the time thus wasted (there is no other word for it) is considerable; but when a great number of such works, on different astronomical subjects, pass through an astronomer's hands weekly or monthly, as is the case with me, the nuisance becomes quite serious; and when we remember that this is so in the case of one person alone, we see how large the total waste of time and trouble thus arising must necessarily be.

The geographer is similarly annoyed. In comparing French, German, or American maps with English maps, or geographical statements by geographers of other countries with similar ones made in England, the geographer finds that every detail depending on longitude has to be corrected or translated before the full significance of the foreign charts or statements can be appreciated.

In fact, this question of a meridian of reference may be regarded as affecting our view of the earth from without, as it were, more importantly than the view we take of the earth as residents in this or that part of her surface. It is the earth as a rotating planet which has now been definitely marked for reference, so that all astronomers and all geographers measure from one and the same mark, not each set from a mark of their own. Just as astronomers use a fixed meridianal marking on Mars by which to time the rotations of the planet, so in future will astronomers and geographers act with regard to the earth. Strange that they should have assigned a fixed meridian to a planet many millions of miles away, many years before they assigned a fixed meridian to their own planetary home!

It may be asked whether the adoption of a fixed meridian for the whole earth will affect the question many find so perplexing, as to what day of the week it is at particular places, and at particular times. Here it is to be noticed that the usage of astronomers and the usage of business folk must of necessity differ. To the astronomer there will now be, what hitherto there has not been, a definite series of days, the same all over the world. What people in England call, for instance, November 17, viz., the interval of time between midnight and midnight on either side of that day whose middle is noon November 17, has been for the English astronomer, and will hereafter be for the astronomers of all countries, divisable into the last twelve hours of November 16 (which ends for the astronomer at noon November 17) and the first twelve hours of November 17, whose remaining twelve hours, numbered from 13 to 24, end at noon November 18, civil time. So, all round the year,—December 25, for instance, in astronomical time, will include for all astronomers, the twenty-four hours from December 25, 12 noon Greenwich mean time, to 12 noon Greenwich mean time, December 26.

But as to what day of the week it is at any particular place and time, the difficulty, which many imagine to exist only along the meridian half-way round the earth, west or east of Greenwich, has always existed, and will continue to exist, all over the earth. It is true that when we travel westwards or eastwards from Greenwich, we have to make a change of a full day, one way or the other, when near the meridian, which lies 180 deg. east (or west) of Greenwich. But that is only because we have not made the necessary partial change at each successive stage of our journey west or east of Greenwich. Or it might, perhaps, be rather said that small partial changes are made stage by stage in passing westwards or eastwards, which amount to half a day where two voyagers travelling westwardly and eastwardly at equal rates would meet; and these changes being in opposite directions, the two half days must be made into a whole day at the place where the voyagers cross each other, the westwardly voyager now taking the days (one ahead of those he had been using) of the eastwardly voyager, and *vice versâ*. But the difficulty as to the day of the week exists all along, and is actually felt (which is different) wherever we pass across a line dividing two regions where different local time is used. Thus, suppose we are on a train travelling westwards from New York, and pass, at half-past twelve at night, a place where, along that railroad line, the change of an hour is made. It is, let us say, Tuesday morning early (half-an-hour after midnight) before we pass that place; but so soon as we have passed the place of change, it is no longer Tuesday morning but Monday —night—half-past 11 p.m. By passing to and fro across the line of change, at any hour between 12 midnight and 1 a.m., for the eastward region, or (which is the same thing) between 11 p.m. and 12 midnight for the westward region, we can make the day of the week change as often as we please, or have any number of Mondays and Tuesdays, Tuesdays and Wednesdays, &c. (as the case may be), in the course of a single hour. But the difference of day in such a case as this is a matter of no moment, and needs no correction, whereas it would be a matter of serious moment if every one who had circled around the earth either eastward or westward remained a whole day behind or in advance of those among whom he lived. It is obvious that as the westward traveller keeps on adding hour after hour to his time, he must add a full day by the time he has gone completely round, and unless he dropped a day somewhere, he would be a day behind the friends whom he had left at home by the time he rejoined them. The opposite change must be made by a traveller going eastwards; and clearly the proper place for the change is when either is half-way round; for by making it there the discrepancy never exceeds half a day.

It is noteworthy, however, that the only place where the day exactly corresponds with the Greenwich astronomical day is along the meridian just westward of but touching the meridian farthest from Greenwich. Thus, the astronomical day—November 17th—runs from November 17th noon to November 18th noon (Greenwich mean time); and at a place just short of 180° west of Greenwich November 17th also begins at noon November 17th (Greenwich mean time) and ends at noon November 18th.—*Newcastle Weekly Chronicle.*

In the December number of the "Miscellanea Genealogica et Heraldica" there is the facsimile of a very rare, perhaps unique, funeral card; the original is at Hardwick, among the collections formed by Sir John Cullum, Bart. This card entitled the bearer "to accompany the Corps of Mr. *Thomas Moody*, from *Armourers-Hall* in *Coleman-Street*, to the Burying Ground on *Bun-Hill*, on *Friday, May* the 18th, 1716, by Five of the Clock in the Afternoon precisely.—And bring this Ticket with you." Although the Bunhill Fields Registers corroborate the date of Mr. Moody's burial, yet there is no monument now in existence to his memory.

OUR SCIENTIFIC INDUSTRIES.

By W. Slingo.

II.—GAS AND ITS USES—MANUFACTURE—(*continued*).

IF anything were wanting to demonstrate the truth of the old saying that "history repeats itself," we can surely find it in the history of illuminants. To-day it is proposed, with all seriousness, to deliver at our doors daily a source of electricity whence to derive the current to maintain the electric light, and ninety years ago the self-same proposition was urged, and more than urged, on behalf of gas.

In the first days of gas manufacture it was collected in bladders, leather, varnished silk, and metallic vessels provided with a small tube and stopcock, through which "the gas issuing from a minute orifice was ignited and made to serve as a lantern." Important as is the question of gas-storage, it is scarcely more so than is the question of orifices or burners, and we shall find that there are many interesting features concerning them well worthy of consideration.

Murdoch, to whom brief reference was made at the close of the previous article, had some little prescience of the value of the work he had taken in hand, and tried very hard to induce James Watt, son of *the* James Watt, to take out a patent with him for the process. But his efforts were unavailing, and the process for obtaining an illuminant from coal became public property, although in France an engineer, Lebon by name, obtained in 1799 a patent for a similar process. Exhibitions of the new light were made by Murdoch at Birmingham in 1798, and on a larger scale four years later. Lebon's experiments were repeated in London in 1804 by Winsor, who then and subsequently strove very hard, albeit ineffectually, to prove the priority of Lebon's invention. During the earlier years of the century Murdoch appears to have been busily engaged in erecting works for private houses, mills, &c. One of the more important of these "installations" was that in the extensive cotton-mills of Messrs. Phillips & Lee, of Manchester. "The burners were of two kinds, one on the principle of the argand lamp, the other a cock-spur burner, consisting of a small curved tube with a conical end having three circular apertures or perforations about one-thirtieth of an inch in diameter, one at the point of the cone and two lateral ones. The gas issuing through these apertures formed three divergent jets of flame somewhat like a fleur-de-lis. The whole of the burners erected in the mills amounted to 271 argands, each of which gave a light equal to four mould candles of six to the pound, and 633 cockspurs, each of which gave a light equal to two and a quarter of the same candles. The quantity of tallow consumed by each candle was at the rate of four-tenths of an ounce per hour." The cost of the gas even then was computed at less than a third of that involved in the use of candles. An account of this work having been communicated by Murdoch to the Royal Society in 1808, he was awarded the Rumford Gold Medal, and a year later Clegg, another worker in the same field, was awarded a silver medal for a communication to the less exclusive Society of Arts.

Winsor had, however, in 1804, obtained a patent for the extraction of gas from coal, and, although Murdoch succeeded afterwards in proving his priority, his competitor had the field very much to himself. The path of Winsor was, however, no more bestrewn with roses than are those which lay before the electricians of to-day. Prejudices and interests of all kinds had to be confronted and borne down ere the supremacy of gas over oil and tallow were established. We are all well acquainted with the scarecrow held up to the followers of Stephenson, whereby it was gravely predicted that the breed of horses would diminish in consequence of a decrease in the demand for those animals. Some, in their enthusiasm, went so far as to prophesy an almost total extinction of the breed, and to express a fear that the time was not far distant when we should regard the noble equine as a something relegated to the pages of more or less ancient natural history. But even worse evils were foreshadowed for those who would have the misfortune to exist in post-oil days. The early portion of this century was notorious for the victories of Nelson, which demonstrated the naval supremacy of England, but, said the opponents of the newly-introduced illuminant, "if this (gas-light) becomes successful, then our naval supremacy is gone, for at present we obtain principally our artificial light from the Whale Fisheries. These are the nurseries of our best sailors; therefore, if we destroy the one, the other must be affected. If the fisheries no longer exist, our navy must degenerate."

Great dangers to the community were anticipated in the event of steam being adopted for locomotive purposes, as also are they at the present day from electricity. Similarly it was feared that the explosion of a gas-main under the streets would destroy a town. Another parallel is, however, unfortunately, discernible. As in the present day ignorant and over-sanguine "electricians" have taken upon themselves to champion the electric light, and have tried their hardest to make the world imagine that it is to be revolutionised by the electric light, so likewise did many would-be fathers of gas-lighting do a deal of harm, and bring down upon the system ridicule and trouble. Even Winsor himself could not keep to fair and truthful lines, for it is recorded that he "often committed the most egregious errors, at one time asserting that our atmosphere in its pure state was too powerful, and that a mixture of coal-gas rendered it more salubrious; again, that gas would not explode when intermixed with air, and that its adoption would purify the atmosphere; whilst the prospectus issued by him contained most extraordinary exaggerated and fabulous accounts of the enormous profits to be derived from gas-lighting."

However, progress was made, although, of course, less rapidly than would have been the case had less extravagant pretensions been urged, and in 1807 Pall Mall was lighted with gas; Westminster Bridge was similarly lighted in 1813, and in 1814 gas lamps were substituted for the oil lamps in the parish of St. Margaret's, Westminster. In the latter year, a great effect was produced by illuminating a pagoda erected in St. James's Park with 10,000 jets of gas, lighted instantaneously, and forming "an immense and brilliant fountain."

Many of these and other experimental displays were made by a company formed by Winsor. The original company was formed in 1808, and their object was to obtain the exclusive privilege of lighting all the British possessions with gas. And for this task they proposed to raise a capital of £1,000,000! After several reverses the "Gas-Light and Coke Company," with a capital of £200,000 was established, and secured a royal charter in 1812, with privileges, however, far short of their original ambitious desires, and teeming with disadvantages. They were not allowed to extend their operations outside London, and were not in the least degree protected against competition, should any possible rival have the temerity to enter the field against them.

Under such inauspicious circumstances was the first gas company started. They had many other troubles to contend with, both inside and out, and the only wonder is that they survived the ordeal. If it proves anything, it proves

that there were good and substantial grounds for the promoters to work upon, that the commodity they were offering was valuable, and must ere long take its place, and that a prominent one, in the market. A few years served to demonstrate this, and in 1820 nearly every town of importance had made a start, the light having created in the minds of the people a great feeling in its favour; so much so, that we read of a prominent Frenchman who, in writing to a friend says, "Where gas-light exists there is no night; where gas-light is, there is continuous day."

Having said thus much on the early history of gas production and lighting, it would best accord with the object in view if attention is now turned to the manufacture as at present carried on. There is one thing to be noticed, however, before quitting this portion of the subject, viz., that before many months had passed over the heads of the Gas-light and Coke Company they had competitors in the field, and then began one of the most ruinous struggles for supremacy ever known in the history of any industry. The futility and cost of these struggles should read to us to-day an important lesson. There was room for many gas companies; in 1829 two hundred were formed in the United Kingdom, and there was, doubtless, scope for more. We have a few electric light companies, but they are given up too much to fighting; there is room for the gas companies, as well as for them and for others too, but they must learn how to discriminate between a good market and a bad one.

THE TRICYCLE IN 1884.

By John Browning,

Chairman of the London Tricycle Club.

SAFETY BREAKS.

BEFORE the year closes I should like to say a few words respecting breaks.

The break is one of the most important parts of a tricycle. Since vertical pedalling—that is, sitting directly over the pedals—has been the rule, the rider has lost much of the power formerly possessed of arresting the forward motion of the machine, whenever it is necessary, by back-pedalling.

Again, many machines are now ridden with clutches, and these, of course, give the riders no power of back-pedalling. In all such machines a most efficient break is indispensable.

The band-break introduced by the elder Starley, the father of the modern tricycle, has never been beaten in efficiency. On one of the first Sociables he made I descended the worst of the two hills at Westerham with my wife, and, although I have done this many times since on various machines, I have never had another Sociable in which I could descend it so safely and easily, for, while with every other Sociable I had to ride down carefully, with the Starley machine I could let it run at ten or twelve miles an hour, and pull it up on a steep part of the incline in twenty or thirty yards.

Many Sociables I have tried for my friends have proved efficient in every other respect, but, the break being ineffective, have caused them months of trouble and anxiety.

Nearly the worst accident that can happen to a tricyclist is for the break to give way on a steep hill.

When it does so, the best thing to do is to turn the machine round, if possible, into the side of the road, before the pace becomes alarming.

I have done this once on a Sociable, and twice on single machines without getting a scratch myself or in any way injuring the machine.

On the last occasion I was descending from Chipstead to Merstham, by what I suppose the parish authorities call a road, but I should call a water-shoot, when it came on to rain suddenly and heavily. I was on my small Humber, which I was holding in by the break easily. But, after a few minutes, I found my pace increasing in spite of the utmost pressure I could apply to the break. As the machine had a clutch in the lower chain-wheel, I could not pedal backwards. I was at a sharp corner and heard the sound of wheels below me, so immediately put my machine into the bank, and the shock threw me off backwards, unhurt.

My reason for mentioning this little mishap is that I find few riders are aware that heavy rain will lubricate a break so as to render it nearly useless. The moral, of course, is that you should dismount if you have to descend a steep hill when it is raining heavily.

I have long been of opinion that to avoid such mishaps all tricycles should be provided with a second, or safety, break. The first safety-break which I thought useful was that introduced by Pausey, who put two breaks upon a machine of the Humber type. They were two separate band-breaks, acting on the same drum, provided with separate levers, one actuated by the right hand, and the other by the left. As either or both of these levers could be used without leaving go of the steering-handles, this appeared to me an admirable arrangement, and I am surprised that it was not generally adopted.

The Sparkbrook Tricycle Company have just introduced a new safety-break specially adapted for the Humber Tricycle. This is a band-break, working on a drum attached to the lower chain-wheel, the band being acted on by the step which is just behind the lower bracket. The break is applied by placing the foot on the step. To do this the weight of the rider must be thrown so far back that it is contended that there will be no risk of his being thrown over the handles.

I shall certainly adopt this as a safety-break on my small Humber, if I can do so without relinquishing the excellent two-speed gearing which Mr. Bown has just fitted to the machine for me.

By far the simplest and most efficient safety-break yet seen has just been introduced by Messrs. Lloyd Bros. on their new No. 8 and No. 9 front-steering Quadrants.

Instead of attaching the mud-guard of the front wheel as a fixture by the upper end, they have made it stout, and attached it by a spring and hinge fixed at the lower part. In case of need, the rider can place his foot on the upper part of the mud-guard and press it firmly against the tire. As the front wheel in this machine is 26 inches diameter, this would no doubt prove a sufficiently-powerful break even were there no other on the machine, but with the band-break which Messrs. Lloyd Bros. put to their roadsters, it might be said that the break arrangements would be perfect, and an accident from deficiency of break-power impossible.

According to the *Drugman*, the Japanese are threatened with severe losses on account of the extinction of the lacquer industry. The tree from which the varnish is made is disappearing. An old law compelled the people to rear lacquer trees, but it is not now in force. Another law compelled every person who cut down any kind of tree to plant two in its place. This also has become a dead letter, and the native newspapers fear the deforestation of Japan.

International Exhibition.—Gold medal (highest award) has been awarded to Messrs. Walker & Harrison, of the Phœnix Biscuit Works, Ratcliff-cross, London, E., for their new Phœnix Carbonated Meat Biscuit for Dogs, &c.—[Advt.]

THE EARTH'S SHAPE AND MOTIONS.

By Richard A. Proctor.

CHAPTER VI.—THE EARTH'S ROTATION.

(*Continued from page* 421.)

WE note then that if a ring of particles A B C D (Figs 1 and 2) is rotating in direction A B C D, and we wish it to rotate in direction *a* B *c* D, we must apply forces tending to carry B in a direction contrary to that in which we wish A to be carried, and in the same direction as we wish C to be carried. On the contrary D must be thrust in the same direction as A is to be carried and in the direction contrary to that in which we wish C to be shifted.

The rule may be thus stated:—Having a rotating disc A B C D, whose plane of rotation we wish to change, so that two opposite points as A and C, in Figs. 3 and 4, may be shifted in opposite directions, at right angles to the disc's plane, the intermediate points B and D not shifting, we must move the disc as if trying to make the points B and D move in the direction in which C and A, respectively *a quadrant in advance* of them (according to the direction of rotation), are required to move.

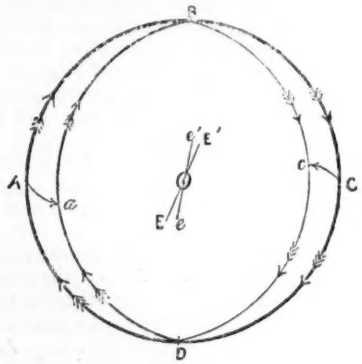


Fig. 1.

The converse rule may be thus stated:—If a rotating disc A B C D be so urged by impressed forces that were it at rest the points B and D would be carried in opposite directions at right angles to the disc's plane, the points A and C not shifting, then will the plane of rotation be actually shifted as though the points A and C, *a quadrant behind* B and D respectively, had been carried in the directions in which B and D are respectively urged.

In all such cases the bodily translation of the rotating disc must be considered separately.

I have been careful to explain thus far the principles on which the ordinary experiments with the gyroscope depend. They serve to show how and why the median plane of a heavy rotating disc, spheroid, or sphere, resists any attempt to change the position of its axis of rotation, and why such change as does take place is at right angles to the direction in which the external forces would move the axis of the disc were it not rotating. Moreover we can understand why even considerable external forces acting on a heavy disc rotating very rapidly, change very slightly the position of its axis of rotation.

But in Foucault's experiment for exhibiting the earth's rotation by means of the gyroscope, everything was done to prevent the rotating disc from being externally influenced. In the first place, the gyroscope is made very heavy, and set in very rapid rotation. This makes its power of resisting a pressure tending to change the position of its axis very great. Then, secondly, all possible care is taken to diminish the effect of the tendency which really acts upon it to change the position of its axis. This force is the earth's rotation acting upon the gyroscope, through its supports, whatever they may be. If we make the gyroscope as free as possible this force will be diminished as much as possible. Now this is precisely what Foucault sought to do. In his gyroscope for exhibiting the earth's rotation, there is first a vertical ring suspended by a thread, and supported on a pointed pivot which rests on an agate plane. So carefully is this suspension managed that when the vertical ring is loaded with the heavy disc (at rest), the merest breath causes it to shift its place. Next within the vertical ring there is one placed horizontally, supported on knife edges which rest on two suitable shoulders at the extremities of

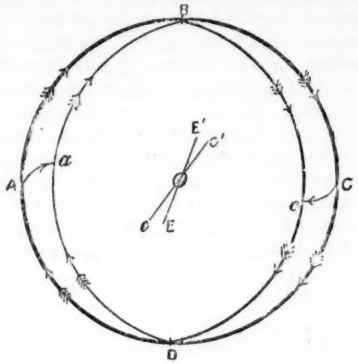


Fig. 2.

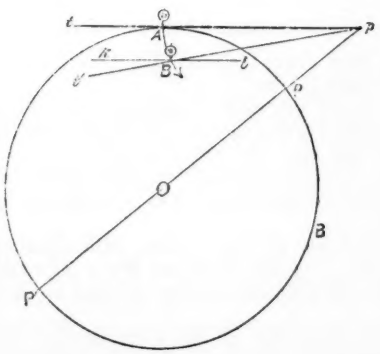


Fig. 3.

Fig. 4.

the horizontal diameter of the vertical ring. Thus this ring can oscillate freely on a horizontal axis. Lastly within the horizontal ring, and on an axis at right angles to the last-named one and also horizontal, is the massive disc.

When the disc is set by suitable machinery in rapid rotation, it tends, according to the principles already enunciated, to preserve its axis of rotation in a fixed position. If the earth were not rotating, it is clear that the axis of the disc's rotation would preserve its position unchanged without any appreciable effect resulting. But if the earth rotates, the axis of the disc can only maintain itself in an unchanged position in *space* by an apparent motion within its supports.

Suppose, for example, that there is a gyroscope at a point A in the rotating earth P A P' (Fig 3), with the median plane of its heavy rotating disc north-and-south, as shown in Fig. 6 at N S. Let this gyroscope be carried by the earth's rotation around her axis P O P', to the position B.

Then if the gyroscope were not rotating the median plane of the disc would still remain north-and-south. Thus, supposing t A p, the tangent north-and-south line to the earth's surface at A, meeting the earth's axis, produced, at p, the median plane of the gyroscopic disc which had coincided with t A p when the gyroscope was at A, would coincide with t' B p the north-and-south tangent line through B, when the gyroscope was at B. This would correspond with the direction n C s in Fig. 6, a direction inclined to (or displaced from) N S. But in the actual case of a heavy rotating disc, there would be no such displacement, unless the attachments of the axial supports were rigid, in which case of course the rotating disc would be forced irresistibly by the overwhelming power of the earth's motion to retain its north-and-south position. In the case of the delicately-poised gyroscope of Foucault, the median line N S would only be affected by such portion of the earth's action as was conveyed through the suspending line, and at the knife-edges supporting the internal ring, and this action—in accordance with the principle we have considered—instead of shifting N C S to the position n C s (Fig. 4), can only slightly shift the uppermost point C towards c (the rotation being in the direction indicated by the arrows), leaving the points l and k (corresponding to N and S) on a line parallel to N S. Thus if a horizontal telescope is directed to the median line of the disc, at N or at S, this line will appear to move in a direction opposed to that of the earth's rotation, the northern side moving towards the east as at l, the southern side moving towards the west as at k.

Thus, when observed under telescopic power, the gyroscope is seen steadily travelling against the direction of the earth's rotation, at the precise rate which calculation shows to correspond to the latitude of the place of observation. For the time being, the gyroscope is, so to speak, like *an independent planetary body with its own proper polar axis directed constantly to the same point of the celestial sphere.*

We are led naturally to the proof of the earth's rotation derived from the precession of the equinoxes. The earth's mass in rotation is a species of gyroscope; and were the earth a perfect sphere it would rotate for ever with its polar axis in a constant position. But the earth being oblately spheroidal, external bodies have a sort of pull upon it, in a manner precisely resembling that which we have conceived as operating upon our experimental gyroscope as above illustrated. The proof of the earth's rotation derived from the consequent slow change in the position of the earth's axis is not, however, founded on the accordance of the observed effects, with dynamical theories—though this accordance is a very strong argument *per se*. It is the fact that by the *precessional* motion of the earth's axis, and the similar but smaller motion called *nutation*, all the stars in the heavens, *and the planets also*, seem to be affected with a species of tremor, which affords the most convincing proofs of the earth's rotation. It is obviously unreasonable to suppose that the stars and planets which we have already seen to be disassociated from each other as respects their principal movements, should only resemble each other in the matter of these strange, tremulous motions. When we see, on the other hand, that a simple dynamical theory, the results of which we can readily confirm by experiment, accounts for all these observed tremors, as due to a peculiarity of the earth's rotation, we can afford to smile at the philosophers who hope to simplify astronomical conceptions by setting the earth at rest in the centre of the universe. Indeed, the proof of the earth's rotation thus derived is as effective as the proof of the earth's revolution derived from the aberration of the fixed stars; it is not, however, so readily rendered convincing to those unfamiliar with the abstruse branches of mathematics.

Lastly, there remains to be mentioned the proof of the earth's rotation derived from the observed rotation of the primary planets. It has been established by the most satisfactory modes of measurement, that the planets are globes like our earth, some inferior to her in magnitude, but others far surpassing her. These bodies are seen to be in rapid rotation upon their axis, those of them which most closely resemble the earth performing a complete rotation in about twenty-four hours. The argument deduced from this circumstance is powerful in itself; but its force will be more clearly seen when we proceed, as we are now to do, to consider the proofs of the earth's revolution round the sun.

(To be continued.)

GORHAM'S PUPIL PHOTOMETER.

THIS beautiful and most ingenious instrument, to which our attention was first called by Mr. Tindall, in a letter (1500) which appeared on p. 391, is as simple as it appears to be effective. It consists of a piece of bronzed tubing about 1·9 in. long, and 1·5 in. in diameter, with one end closed by a disc, in which are a series of pairs of minute holes pierced on radii of the circle, and drilled with absolute accuracy at distances varying from ·05 in. to ·28 in. apart. A cap with a radial slot in it so narrow as only to leave one of these pairs of holes visible at a time rotates over the brass disc; and round the cylinder just below the edge of the cap the linear distance of each pair of holes is engraved exactly opposite to it. Our first figure represents

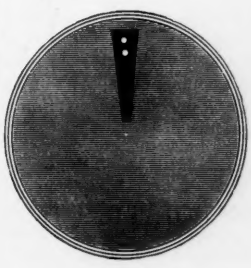


Fig. 1.

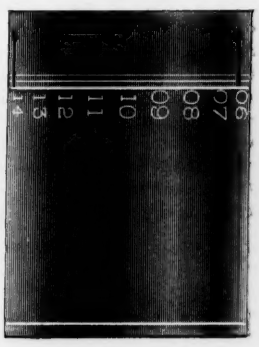


Fig. 2.

the cap as seen when looking down on to it. The pair of holes ·10 in. apart are shown as visible through the slot. Fig. 2 exhibits the tube as seen sideways, to show how the figures are engraved upon it. The instrument seems to have been originally devised by Mr. Gorham for measuring the diameter of the pupil of the eye under the stimulus of light of varying intensities. It is used by looking through the open end of the tube (the bottom in Fig. 2), when two discs of light will be seen, like a double-star. The cap is turned until a pair of these discs appear which are precisely tangent, or *just* touch one another at their edges. Then may the diameter of the pupil be read off on the scale by mere inspection to ·01 in. But this is by no means the only—or, in fact, the chief—use of Dr. Gorham's instrument, inasmuch as the magnitudes of the pupil really furnish the measures of the intensities of the lights under whose influence its diameter varies. Hence it may be used as a photometer; and for this purpose we proceed as

follows :—We set a Sugg's standard candle at a distance of 1 ft. from the eye, with a white surface (such as a sheet of foolscap paper) behind it, in a room otherwise totally dark. We now take the diameter of the pupil in the way just indicated, and read it off from the scale. Leaving the photometer intact, we substitute for the candle the source of light whose intensity we wish to measure, placing a white background behind it, as in the previous case. Suppose that it is a duplex lamp which replaces our original candle. If we regard this from a distance of 1 ft., as before, we shall find our two discs of light, so far from touching, will be pretty widely separated, and we must slowly retire from the lamp until the circles have expanded sufficiently to become tangent again ; when, of course, the pupil will have regained its original dimensions, from the light falling upon it being of identical intensity with that of the candle. It only remains to measure the distance of the lamp from the eye in feet and decimals of a foot to find its illuminating power, which obviously will vary as the square of the distance (vide p. 130), *i.e.*, if we have to retire to a distance of 4 ft. the lamp must give the light of sixteen candles, and so on. In a foot-note to Mr. Tindall's letter on p. 391, a doubt was expressed as to the efficiency of Dr. Gorham's invention as a *quantitative* light-measurer. In connection with this we may mention that, as a preliminary to penning this article we have been experimenting with a candle and a small reading-lamp, the relative intensities of whose lights we measured in succession by Rumford's method (Fig. 24, p. 130) and by the instrument we are describing. By the former mode of measurement we found that the lamp gave 7·1113 times the light of the candle; by the new photometer it came out 7·111! It would perhaps be idle to contend that no element of "fluke" entered into this extraordinary coincidence; but it may serve to show with what minute accuracy the relative intensities of various illuminating agents can be measured by this most simple apparatus. The incipient user of it will find it politic to keep his unused eye open ; as, if it be closed, and then opened while the photometer is being employed, the stimulus of the light on the freshly-exposed pupil will cause the one viewing the hole itself to contract sympathetically ; and so derange the measurement. Mr. C. Coppock, of New Bond-street, is the maker of this photometer.

THE STANDARD OF POLITICS IN AMERICA.

THE Rev. Heber Newton, in the course of an eloquent discourse on the low standard of moral ideas in American politics, made the following remarks, which will be read with pleasure by all who wish well to the great nation of our kinsmen on the other side of the Atlantic :—"I have nothing to do," he said, "with the truth or falsity of the charges preferred against the man who has barely missed election to the highest office in the gift of our people. But I would point out the danger which menaces our country through the easy deflecting of the conscience to party interests. Hosts of men have practically said: 'This is a big fuss about nothing. Our leader is not charged with having directly stolen anything. The most than can be said about him is that he has kept his weather eye open to the main chance, and that he used his ruling as a speaker as a plea on which to obtain private wealth. Why should he not have done all these things? If he threw away good chances that did not involve stealing to enrich him, the more fool he. Who of us would not do what he has been accused of doing if we had the opportunity? We like him all the better for not being over-scrupulous. The great American people believe in a smart man.' I fear that a great body of by no means bad men have followed a really able leader, not because they believed him to be free from fault, but because they rather like the faults alleged against him. Lots of men regarded him as the great American, because of his supposed acting forth of those by no means noble qualities which unfortunately characterise us as a people—because of which we ought to feel alarmed. If he really typifies our average American idea of smartness, then again we have not merely a sad feature of a political campaign, but a sadder symptom of a low tone of honour—a sign of the times which it behoves us to ponder. The sting of Dickens' cut at American smartness yet remains. The *Fortnightly Review* recently compared us to Russia, of which the Czar Nicholas said :—'I and my son are the only people who do not steal.'"

CHAPTERS ON MODERN DOMESTIC ECONOMY.

IV.—THE FRAMEWORK OF THE DWELLING-HOUSE (*continued*).

GENERAL PRINCIPLES OF CONSTRUCTION.

THE laying of the parqueterie is, of course, best understood by those whose special avocation it happens to be. The parts of the house adapted to this kind of flooring have been decided upon through a long course of practical experience, until a kind of standard or general routine to be followed has been unconsciously established. The result of our inquiries at Messrs. Howard & Sons' works in Berners-street, W., may be briefly formulated thus :—In a drawing-room the entire floor ought to be covered ; skins and eastern rugs, which can be readily taken up and freed from dust, will be found quite sufficient, upon such a groundwork, to satisfy the most fastidious æsthete. The dining-room should be preferably bordered with parquet, and the central portion carpeted. The bed-rooms ought to be completely covered with this flooring, to which a rug at the bedside may be superadded. The bath-room requires a special lining of cork parquet, the thermal conductivity of cork being such as to afford a comparatively warm sense of touch to the feet on getting out of the bath.

The benefits to be derived from the use of these varieties of flooring are chiefly of sanitary importance :—(1) freedom from accumulations of dust ; (2) the ease with which they may be cleansed ; (3) even when washed with a wet cloth they do not absorb water, and hence are not liable to create damp ; (4) they are beautiful and durable.

Although private dwelling-houses would be immeasurably superior in every respect if floored with parquet work, the system is particularly to be commended for public and other large buildings. In ball-rooms the floors may be polished with wax, and thereby rendered delightfully smooth, in addition to their quality of being and remaining absolutely level ; but for hospitals it is the flooring *par excellence*. When Messrs. Howard were engaged in laying the floors of Westminster Hospital, they were obliged to take up the boards and match them properly before laying on the parqueterie. In doing so they discovered little conical heaps of dust over every supporting joist between the ill-matched floor-boards. It is needless to conjecture the evil effects of such a state of affairs ; every time that water was made use of in cleansing and scrubbing, the little cones of dust, probably teeming with zymotic disease-germs,

would be irrigated, and thus favour the special conditions for the propagation and dissemination of the deadly *bacteria*.

This leads us to observe that where the question of outlay interferes with the employment of parquet floorings, it is incumbent on the builder to pay special attention to the construction of his floors. He ought either to have the floor-boards accurately matched and fastened, to prevent the after-effects of possible warping or shrinkage of the wood, or he ought to have all the interspaces carefully caulked, as on the deck of a ship. We shall revert to the employment of sanitary floorings in a subsequent chapter, when we come to deal with the subject of house furniture.

Closely related to ventilation and the exclusion or ready removal of dust and dirt from a house, comes the consideration of door and window construction. Where no special provision is made for the introduction and outlet of air, it usually happens that the defective fitting of doors and windows is forced to fulfil those functions in a peculiarly disagreeable manner. Not only do they ventilate the rooms by constant draughty currents of air, but they permit of the entry of damp, dust, and dirt from the passages of the house, and even from the streets; so that, when we come to apply a reform to doors and windows, we must look to the adequate admission of fresh, and the expulsion of polluted, air. To a large extent, the average door and window would suffice, provided that the ventilation is well attended to. The air would in such a case find its way into the room more readily through a well-devised inlet than by means of the adventitious chinks of doors and windows. Yet, to provide against the extraordinary incursion of air, the fitting of the latter ought to be as perfect as possible. This, however, is not so easy to accomplish as it would seem to be at first sight. The enormous expenditure involved in the necessary outlay for thoroughly well-seasoned wood and skilled, careful workmanship would swallow up the profits of the builder in the erection of that class of houses, such as artisans' dwellings, &c., which bring him in his most easily-realised income.

As a rule, the doors of houses, in the course of time, tend to shrink; and in such a way as to increase the space at the bottom which has been left for the easy working of the arrangement. Let us premise that the room or passage to which the door gives access is provided with suitable ventilators; then the base of the door ought to fit so closely as to prevent the entrance of draught, dust, or rain. Now, apart from great expense, this is almost impossible to secure in ordinary joinery, inasmuch as the wear and tear of the floor would alone suffice to renew the evil in the course of time. It is possible, however, to adapt a movable piece to the basal edge of the door which shall be simple, self-acting, not liable to get out of order, inexpensive, and quite effective. Such an apparatus is Warhurst's "Automatic Draught Preventer."

Mortality statistics show that, in London alone, no fewer than 80 persons annually lose their lives through falling out of windows. In the majority of instances, the primary cause of death may be traced to the incautious cleansing of the windows. Although it is possible to clean the outer face of the panes of glass in an ordinary window from within the room, it is so excessively awkward a task that the greater number of servants and professional window-cleaners prefer the risk of getting out on to the ledge, and they are thus often overbalanced, and either killed or severely injured. To prevent the possibility of such accidents, the sashes of the window ought to be capable of a wicket, or revolving, as well as a sliding, motion; these not only serve to enable the operator to clean both the inside and outside of each pane easily without incurring any dangerous risk, but they afford a space, when swung open, large enough to allow of the admission of pieces of furniture which are too bulky for removal through doorways and passages. Patent arrangements, which incorporate the advantages which we have indicated, and are in addition draught and dust tight and not more expensive than those in general use, are now in the market. Of these, Adams' "Anti-Accident" Window and Penny's "Double-Action" Window-sash and Frame are the most noteworthy.

The improvements in locks and fastenings for window-sashes, doors, &c., have hitherto been devised chiefly as protective measures against housebreakers. Although they occupy but a subordinate place in the general structure of the house, they are nevertheless well worthy of careful consideration. Burglar-proof sash-fasteners and locks are usually of superior quality and construction, and, as such, secure a firm fastening which prevents rattling, and thereby contributes to the sanitary condition of a house by excluding dust and dirt. In future chapters we shall give examples of the several inventions which illustrate the principles we have here noted, so that our readers may be able to glean benefits of a practical character from our observations.

Reviews.

SOME BOOKS ON OUR TABLE.

Elementary Text-book of Trigonometry. By R. H. Pinkerton, B.A., Oxon. (London: Blackie & Son.)—For those who have the advantage of a tutor, we have little but praise to give Mr. Pinkerton's little book, treating, as it does, in a lucid form, of plane trigonometry as now taught. One excellent feature is the number of numerical examples supplied in it. It is surprising how much more readily the beginner grasps the meaning of a concrete example than he does that of the formula whence it is derived. Our author's sole innovation, so far as we have been able to detect, lies in the substitution of the word "radian" for what we have hitherto been accustomed to call "circular" measure. The two comparatively trivial faults we have to find with the book are, first, the wasting of more than a page by a description of the "Grade" and its application, this form of measurement being now absolutely exploded and disused; and, secondly, the omission of all reference to arcs in the description of the trigonometrical ratios. This is all very well in the case of the student with some preliminary knowledge of the subject, or who has a tutor at his elbow; but seems too abstract for any one approaching it for the first time. The space wasted on the "Grade" had better have been occupied with the time-honoured circle of our fathers' days. The learner would then have seen to *what* certain lines were tangents and secants, at all events.

Charles Darwin. By Edward Woodall. (London: Trübner & Co.)—This reprint (from the Transactions of the Shropshire Archæological Society) of a succinct biography of one of the (if not the) very greatest and most philosophical naturalists the world has ever seen, supplies material for thought to Englishmen of all ages, rousing, as it must do, emulation in the young, far from unmixed sorrow in their seniors, but pride in all. In this record of a noble life we trace the grandson of the author of "Zoönomia" and the "Loves of the Plants"; from his birth at Shrewsbury in 1807, through the Grammar School of that town, the Edinburgh University, and that of Cambridge, until, on the recommendation of Professor Henshaw, he was appointed naturalist to the *Beagle* expedition to

South America in 1831. This was a turning-point in Darwin's career; and but few of those who will read these lines can be ignorant of his narration of his own adventures and observations in his "Journal of Researches." It was during this voyage that those observations were made which culminated in the publication, in 1859, of his imperishable work, "The Origin of Species." How this was howled and thundered at from thousands of pulpits, how it was derided and denounced by the *Quarterly Review* (which, nine or ten years later, had to eat its own words with what relish it might), and how the theologians raved against it at the meeting of the British Association in 1860, will all be found recorded in Mr. Woodall's pages. Truly, the record may make us blush as a nation that such ignorance, fanaticism, and bigotry should be rampant in England during the latter half of the nineteenth century. Of Darwin's subsequent works on "The Expression of the Emotions," Orchids, and structural and physiological botany generally, culminating in the remarkable one on the "Formation of Vegetable Mould" (by earthworms), this is not the place to speak. It may suffice to adduce as an illustration of his astounding patience and love of truth that this last volume was not published until the completion of an experiment which lasted *twenty-nine years*. Probably, of no one who has flourished during the past two hundred years can it be more truly said than of Charles Darwin, that *Exegit monumentum ære perennius*.

The State and Education. By C. H. Schaible, Ph.D., M.D. (London: T. Hodgson. 1884.)—With true German patience, and attention to minute detail, does Dr. Schaible, in his 129 pages, discuss the whole system of State education, from that of the Spartans and Cretans, down to our own School-board epoch. He is, so to speak, a Mundella-ite of the Mundella-ites, and would seemingly, had he the power, give a gratuitous education—we mean, of course, gratuitous so far as the pupils or their parents are concerned—to a large number who now, righteously enough, are compelled to pay for it. Why the half-pay officer or the struggling barrister should have to pinch and deny himself in every possible way in order to educate his children, while the working man is not to do without a single pint of beer or ounce of tobacco that his family may be taught, is not immediately apparent to the man who is no partisan. To all, however, who wish to see a one-sided view of the question ably maintained, we may say that they will find a mass of argument in the work before us.

Drawing to Scale. (London: Moffatt & Paige.)—We have one solitary fault to find with this, otherwise excellent, little tract. It is that in places ′ and ″ are used for feet and inches. These symbols signify minutes and seconds of arc, and nothing in the world else; and it is as legitimate—or illegitimate—to employ them in this way as it would be to make them stand for pounds and shillings, or gallons and quarts.

The Season. (London: 1884.)—Professedly scientific in our aim and purpose, Fashion, in the ordinary sense of that term, is rather outside of our scope. We know not if there be a science of dressmaking; but, if so, it may, we should imagine, be advantageously studied in the pages of the profusely-illustrated magazine whose first number lies before us, and which ought to be invaluable to ladies whose maids are their milliners too.

The Asclepiad. By B. W. Richardson, M.D. (London: Cade & Caulfield.)—There is no falling-off in the interest of Dr. Richardson's journal, valuable as it is to the pathologist and physiologist. The number before us contains a contribution to Dermatology, in shape of two coloured photographs of a man's hand poisoned by bichromate of potassa, so dreadfully natural (and nasty) as almost to deter the layman from touching the page on which it is depicted.

Natural Reason versus Divine Revelation. By Julian. Edited by Robert Lewins, M.D. (London: Freethought Publishing Company.)—The rule which strictly excludes theological subjects from these columns prevents any criticism of the work whose title heads this notice; and we only refer to it here in connection with certain assertions on its seventeenth and eighteenth pages. We there find statements categorically made with reference to utterances in Convocation in 1870 of the then Bishops of Winchester, Gloucester and Bristol, St. David's and Llandaff, which the writer should either be compelled to withdraw, or which demand the most serious consideration on the part of churchmen and orthodox believers generally.

The Disk. By E. A. Robinson and G. A. Wall. (London: Griffith, Farran, Okeden, & Welsh. 1884.)—This weird little American story is full of that pseudo-science which distinguishes more than one of the remarkable romances of M. Jules Verne. It is unnaturally natural, naturally unnatural—we hardly know in which way to describe it—but it is not without interest and a fair modicum of excitement. It is the very book to while away a railway journey with.

Calvert's Mechanic's Almanack for 1885. (Manchester: the Editor.)—An exceedingly useful little hand book for those engaged in the mechanical trades. This is the twelfth year of publication.

Energy and Motion. By William Paice, M.A. (London: Cassell & Company, Limited, 1884.)—An admirably compiled text-book on elementary mechanics, designed and eminently adapted for beginners. The author essays to "lead up to the laws of motion from simple notions rather than, beginning with those laws, to deduce simple notions from them." One important feature noticeable about the printing is that the laws, and other portions which would ordinarily be set up in italics, are set up in an exceptionally heavy type, and are made, therefore, what they ought to be, the prominent and striking feature in an introductory work.

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. New Edition. (London: Longmans, Green, & Co., 1884.)—There is no doubt that electricity is now so far developed as to warrant its being included amongst the exact sciences. Any work on the subject of electricity that ignores or only deals superficially with its measurements is seriously discounted in the eyes of electricians. This book is of the greatest possible utility to the student, and is full of exercises worked out in concrete quantities, and deprived thereby of the forbidding blankness that too often enshrouds purely algebraic formulæ. The book is highly commendable.

The Popular Guide to the Telegraph and Postal Service. By William Lynd. (London: Wyman & Sons, 1884.)—This, to those who purpose devoting their attention to postal and telegraph duties, affords one of the best possible means of attaining that knowledge which is essential to the work. We know of no other publication, except official and therefore exclusive books, which may be resorted to for the purpose. It cannot fail to find a ready market.

Proceedings of the Perthshire Society of Natural Science. Vol. I. Part IV. (Perth: 1884.)—The *Proceedings* before us show what a large amount of real, original, and valuable work may be effected in Natural Science by a local Society devoting itself to an exhaustive examination of its own district. The record of excursions made and papers read is both interesting and instructive.

THE FACE OF THE SKY.

From December 5th to December 19th.

By F.R.A.S.

THE Sun, though low down in the sky, may still be examined for spots, &c. Map XII. of "The Stars in their Seasons" shows the aspect of the night sky. Mercury is an evening star, but is, to all intents and purposes, invisible. Venus glitters still in the morning sky before sunrise, but is losing interest as a telescopic object. Mars is invisible. Jupiter is improving in position for the observer. He rises soon after 10h. 30m. to-night, and before 9h. 40m. p.m. by the 19th. By midnight now he is at a sufficient height for the detail of his belts to be well seen. On the night of the 10th (when, though he is very close to the horizon) Satellite III. will begin its transit at 10h. 28m. Later, Satellite I. will be eclipsed at 12h. 24m. 56s., and Satellite II. will begin its transit at 12h. 34m. Its shadow will pass off at 1h. 2m. a.m. on the 11th. On the night of the 11th Satellite I. will begin its transit at 10h. 47m.; its shadow will leave Jupiter's disc at 11h. 55m., and the satellite itself follow it at 1h. 7m. a.m. on the 12th. On the 17th, the shadow of Satellite II. will enter on to Jupiter's face at 12h. 39m., and that of Satellite III. pass off at 1h. 12m. the next morning. On the 18th, the shadow of Satellite I. will begin to cross the disc at 11h. 28m. p.m., followed by the Satellite casting it at 12h. 38m. The egress of both will take place early on the following morning. Lastly, on the 19th, Satellite I. will reappear from occultation 12 minutes, and Satellite II. 29 minutes, after midnight. Saturn is visible all night long, and is a splendid object in almost any telescope. He continues to travel slowly away from ζ Tauri in a westerly direction ("The Stars in their Seasons," Map I.). Uranus is invisible, and Neptune is still in the blank region in the eastern confines of Taurus. The Moon enters her last quarter at 11h. 30·5m. a.m., on the 9th, and is new at 1h. 24·5m. p.m. on the 17th. Hence comparatively little will be seen of her during the next fortnight. Only two occultations occur during it. The first is of B.A.C. 3122, a 6½ mag. star, which will disappear at the bright limb of the Moon at 11h. 38m. p.m. on Dec. 6, at an angle from her vertex of 95°, reappearing at her dark limb at 12h. 14m. p.m., at a vertical angle of 164° The next night, the 7th, π Leonis will have been occulted before moonrise. It will reappear from behind her dark limb at 10h. 16m. p.m., at an angle of 174° from her vertex. The Moon is in Cancer when our notes begin, but quits it at 6 a.m. on the 7th for Leo, through which she travels until 11 a.m. on the 8th, when she descends into Sextans, only, however, to re-emerge in Leo at 10 o'clock the same night. She finally quits Leo for Virgo at 11 p.m. on the 9th. Her passage through this great constellation occupies her until 8 a.m. on the 13th, when she enters Libra. At 9 a.m. on the 15th she crosses into the narrow northern strip of Scorpio, which at 8 o'clock the same evening she leaves for Ophiuchus. At 5 p.m. on the 17th she passes the boundary into Sagittarius, and is still in that constellation when these notes terminate.

CROWS *versus* WOODCHUCK.

A WOODCHUCK (or ground hog) had its burrow in an elevated piece of ground at the edge of a field of buckwheat stubble along the public road between Monticello and Thompsonville, in Sullivan County. It had been seen occasionally playing in the stubble. A few days ago a flock of crows took up their quarters in a piece of woods near the field, and have since passed their time feeding on the buckwheat, which they seem to find in abundance in the stubble. The other day, a resident of Monticello was driving along the road when he heard a great tumult among the crows. The entire flock was centred about a certain spot in the field, and individual members were darting up and down and to and fro, and always returning savagely to the same spot. The noise of the combined cawing of the fifty throats was deafening, and of that peculiar character which always denotes that the crow has more serious business on hand that the ordinary duties of its every-day life. The man stopped his horse and looked to see what the cause of the tumult was, and discovered that the woodchuck had wandered unsuspectingly into the stubble, and that the crows, taking offence at his presence on their feeding-ground, had attacked him in force. The woodchuck was trying to make his way to his burrow, but, assailed on every side by the sharp beaks and strong claws of the crows, he found his progress exceedingly slow and painful. Now and then, goaded by some especially savage dig from a crow, he would make a show of fighting back, but this only increased the noise and the fierceness of his assailants. Fortunately for the woodchuck, he had been surprised by the jealous crows before he had gone far from his hole. If he had been set upon in the middle of the field he would have been killed, and doubtless eaten, before he got back to his home. As it was, he gradually edged along toward the burrow. The air was filled with flying fur and feathers. The woodchuck would have had some show with a dog or two, but the sort of warfare carried on by the crows was something that rendered his best tactics utterly worthless. After a struggle of ten minutes the poor animal succeeded in dragging himself to the mouth of his hole, and it needed all of his remaining strength to pull himself safely inside of it. The crows circled around and around the spot where the woodchuck had disappeared, filling the air with the most hideous cries, but whether of disappointment or triumph the spectator was unable to say.

Finally, they all alighted on the ground, a few feet away from the burrow, and apparently held a council of war. They cawed and strutted about, first one and then another flying up to the woodchuck's hole, and then back to the council. These movements lasted for five minutes, and resulted in two old crows posting themselves on the fence directly opposite the woodchuck's hole, and only a few feet away from it. The remainder of the flock returned to their work in the field, and not a sound was heard from any of them. The spectator was so interested in the proceedings that he waited for half-an-hour to see if anything new developed. The two crows on the fence, where they had been placed, evidently to give notice if the woodchuck appeared again, remained at their posts as dumb as oysters. No change in the situation taking place, the spectator was about to drive on, when he heard a caw from one of the sentinel crows. The man, supposing that the woodchuck had been unwise enough again to venture out, expected to see the entire flock once more hurry to the scene. Such was not the case. In response to the cry two crows left the flock and flew to the fence, took the places of the two sentinels, and the latter returned to the field. The spectator, unwilling to remain any longer for fear that he might see something done that would not be believed when he told it, drove on. He returned past the field an hour and a half later. There were still two silent sentinel crows on the fence. Subsequently he returned with another man to see what the result of the difficulty between the crows and the woodchuck had been. There were no sentinels on the fence. The men flushed the crows in the field, and the flock took to the woods. A visit was made to the woodchuck's hole. It had been "dug out." The man who had first seen the proceedings declared his belief that the crows had grown weary of waiting for the woodchuck to come out, and had set to and unearthed him. There were about the spot, however, too many evidences of the small boy and a dog for this theory to hold, and it was abandoned.—*New York Times.*

Royal Microscopical Society.—At the last meeting of the above society, a new "Lantern" Microscope, the invention of Mr. Lewis Wright, worked out and manufactured by Messrs. Newton & Co., of 3, Fleet-street, was exhibited by the oxyhydrogen light to an unusually large number of Fellows. The results obtained were, in the opinion of Dr. Dallinger, F.R.S. (president), Dr. Carpenter, Prof. Stewart, Mr. Crisp (hon. sec.), and others, greatly in advance of anything that has previously been obtained, far exceeding in definition the "Giant Electric Microscope" exhibited last year. Among other objects were exhibited the following:—Human thumb (showing perspiratory glands), circulation of blood in living frog, blowfly's tongue (showing spiral formation), &c., besides several anatomical and other slides (echinus spines, &c.) mounted by Dr. Carpenter and others, which were shown on the 14-ft. screen, in a most brilliant and clearly defined manner.

The Rector and Fellows of Exeter College have, says the *Athenæum*, just obtained for their hall a fine portrait of the late Sir Charles Lyell, the immortal author of the "Principles of Geology." Lyell was an undergraduate of Exeter College from 1815 to 1819, when he took a second class in classics and graduated B.A. He received the honorary degree of D.C.L. in 1855. The present portrait is a copy in oils of that executed by Lowes Dickinson two years before Sir Charles Lyell's death in 1875, now in the possession of Mrs. Henry Lyell. Exeter may justly feel proud of Sir Charles Lyell's connection with the college, and has done well in giving a place of honour to the man who made Darwin possible, and was at one time anathematised by society for his demolition of the Mosaic cosmogony. It is a pleasure to reflect on the fact that the present Fellows of Exeter have taken pains to place a really fine painting of Lyell on their walls; for, as far as we remember, the portraits hitherto serving to decorate the public rooms of that seat of learning have been entirely devoted to the glorification of second-rate ecclesiastical dignitaries, and are eminently worthy of their originals.

Our Inventors' Column.

So great is the number of inventions now patented that many good things are comparatively lost in the crowd. A succinct account, therefore, by an Expert, of all inventions of really popular interest and utility must be advantageous both to the public and the Inventor, enabling persons to hear of inventions already desiderated by them, and thus acting reciprocally as a stimulant on supply and demand.

A NEW SAFETY CASH-TILL.

A cash-till designed to show the general takings, and yet keep them safe from any fraud, and so constructed that it cannot be run off with, is surely a desideratum to thousands engaged in various forms of ready-money operations. Mr. A. J. Johnstone, of 140, Mill-street, Liverpool, has, we note, invented a cash-till which is a decided preventive to fraud, is never in the way, and can be seen from any part of the shop. The invention consists of a long, narrow box, having two drawers, the long one moving at right angles to the counter, and the other, which is kept locked, at right angles to the first or parallel to the counter. The first drawer has two compartments for copper and silver respectively. The top is of plate-glass. The small drawer runs below a sliding platform attached to a handle at the side, which takes all gold, notes, or surplus silver passed through the aperture in the plate-glass forming the top of the whole till. Money put in this compartment can remain for the customer to see, and then, by moving the handle, it falls into the locked drawer beneath. On drawing out the larger drawer containing the silver and copper a bell rings, and this effectually prevents any secret tampering with the till. The key of the gold compartment is kept by the principal, who may from time to time transfer the surplus silver from the compartment in which it lies into the drawer, and thus the whole takings of the day need never be at the mercy of any one in the shop. Another special advantage of this improved till is the manner in which it is attached to the counter. Two iron hooks are screwed into the under end of the till below the handle door, so that the hooked part of the iron can run under the edge of the counter. Through these hooks there passes an iron cross rod, as long or short as the requirements of the particular shop may need, and this is fastened to the supports of the counter as far as the length of the rod allows. These tills can be made in any style that may be desired.

DECORTICATING RICE, WHEAT, &c.

Very few persons, comparatively speaking, know how much inventive genius has been expended in the endeavours to remove the outer cuticle of the wheat berry without at the same time depriving it of any of its nutritious properties. Mr. J. H. C. Martin, of "The Drive," Walthamstow, and of 16, Mark-lane, E.C., has invented a machine for thoroughly decorticating rice, wheat, and other grains, which is claimed to possess very great advantages. An emery drum is employed, and made to revolve rapidly within a cylindrical case and set obliquely, and so adjusted that for wheat the machine not only cleans thoroughly, and especially the ends of the grain, but produces the condition needed for roller-milling, the skin in the crease being left thicker than in any other portions, and thence being more easily separated. It is contended that flour made from wheat thus treated would be in preferential demand.

IMPROVEMENTS IN WINDOWS.

The window has long, we think, presented a prominent field for the inventor, and now we observe that Messrs. Verity Brothers, the well-known manufacturers and patentees of sundry special ironmongery appliances for the building and other trades, of 54, Call-lane, Leeds, have patented several important improvements in sash and other windows, whereby perfect ventilation and complete security are secured. The windows, can be cleaned on both sides from the inside, and are rendered perfectly safe by means of Messrs. Verity Brothers' double-locking sash-bolt or fastener. The following are some of the advantages explained:—1. The window can be opened for ventilation without being unlocked or rendered insecure if so left. 2. The strength and safety of the swinging pivots are secured in all positions from the fact that—through the protection and steadiness of the outer sash frame—no undue strain can be put upon them. 3. The above, in combination with the rebate arrangement, renders it impossible for the swinging sash to "tumble bodily into the street," as other constructions have been liable to allow. 4. The construction can be varied, so that the upper sash swings only, without sliding; the bottom sash alone being made to both slide and swing upon pivots, or any other variation architects may suggest or require. 5. The chain opener and fastener has no notched bar or other overhanging projection to become unsightly and objectionable when the window is closed, and can be fixed at the side instead of centre.

CORK-DRAWING.

Although in many quarters screw-stoppers are coming into use for most bottled drinks, the cork is very far from being disestablished yet. Meanwhile, cork-drawing is often attended with much trouble, not the least being the breaking off of pieces, which crumble into the contents of the bottle. Mr. A. Muir, of 2, Walbrook, London, E.C., has, we believe, perfected a machine specially designed for drawing corks with amazing rapidity, certainty, and that by a single operation of the hand. The screw is constructed upon the simplest mechanical principles, and being devoid of complicated arrangements, cannot possibly get out of order, while the leverage power is such that any lady, if need arise, can draw out the tightest cork without effort. Another advantage is that the contents of the bottle remain undisturbed.

THE "CARMICHAEL" PORTABLE BOOT-TREE.

There can be no doubt but that for those who study appearances the boot-tree is an indispensable part of personal *impedimenta* during a round of visits, &c. Boot-trees, however, are cumbrous things, and some time since a cavalry officer conceived the idea of making an india-rubber boot-tree capable of being carried in the pocket, and, when put inside the boot, needing only to be inflated to fill any boot out tightly and render shrinkage, however wet the leather, impossible. This invention has obviously many special advantages over the rigid wooden tree, and should come into very general use. The sole agents for this invention are Messrs. W. Sparkes & Hall & Co., 308, Regent-street, London, W.

A NEW WATCH-KEY.

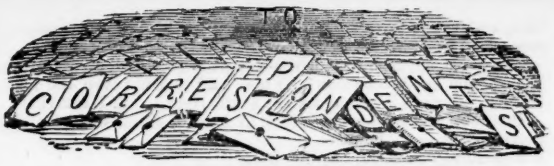
Stem-winding watches have not yet quite disestablished the old-fashioned watch with its separate key. Many endeavours have been made to produce that obvious desideratum, a key adjustable to any watch without any trouble or preparation, and this is now claimed to be accomplished by an invention of Messrs. Vale & Sons. All that the person wishing to wind a watch has to do is to press the key into the winding-square of the watch, which it will at once fit, no matter what the make or size of the watch. We understand that Messrs. Vale & Sons were the very first inventors of a key to wind any watch when, twenty years ago, they produced their screw-adjustable key, and thus a special importance attaches to their new self-adjustable watch-key. This will enable those watchmakers who hold a stock of old-style watches to compete more readily with the keyless variety.

THE NEW BOLANACHI CHOCOLATE.

The invention of a new food-drink, if we may use such a phrase, is surely a matter of no small importance to the community. Some time since M. Bolanachi, a Turkish gentleman, conceived the idea of utilising the ceratonia bean, hitherto used only for cattle-food, and after much labour he succeeded in producing thence a sweet, clear, honey-like extract, the saccharine property of the plant. He next proceeded to try this with chocolate in place of sugar, and as a result of experiments, has now a manufactory of chocolate at Spa-road, Bermondsey, where the cocoa bean, without husk and without flour or starch, is used only with the syrup of the ceratonia bean for making fine chocolates, which do not need boiling, and are claimed to be finer and cheaper far than the ordinary kinds even of the best. The Bolanachi chocolate is a very nourishing and pleasant beverage, and won the highest award in its class at the late International Health Exhibition. The city offices of the company are in St. Clement's House, Clement's-lane, E.C. The new chocolate is a food-drink equally good for the strong and the weak, and is particularly digestive, while its flavour is delicious.

IMPROVED STAIR-ROD "EYES."

Stair-rod eyes of the common sort are often very troublesome, continually coming out and frequently breaking. What is known as Emery's New Patent Stamped Stair-rod Eye appears to be a useful improvement on the old-fashioned cast stair-rod eyes. This eye is fastened by two nails, and, being stamped out of rolled brass, is stronger and cheaper than the ordinary kind. The eyes are at the same time more ornamental. It is obvious that the fixing is much simplified, and the liability to work loose is minimised. Samples of these eyes may be obtained on application to the patentee and manufacturer, Mr. S. C. Emery, 389, Lichfield-road, Aston, near Birmingham.



"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

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The Editor is not responsible for the opinions of correspondents.

No communications are answered by post, even though stamped and directed envelope be enclosed.

IS TEA INJURIOUS?

[1524]—In reply to your correspondents, Messrs. Williams, Gaubert, and Bell, I conclude the above-named gentlemen have had sufficient time to eke out the essence of their subject, but allow me to state the following fact:—viz., that my grandmother lived till the age of eighty-four years, and her sister till ninety-nine years and ten months, each had tea to three meals each day, and both retained all their mental faculties till their decease; and, for my own part, I prefer tea. I also notice a very large proportion of people in far advanced age, and they themselves state that it is preferable to coffee or cocoa, as both the latter cause frequent biliousness. If tea does not prevent longevity, I cannot conceive how it can cause any mental incapacity whatever.

Joe E. Liddle.

DOCTORING WINE.

[1525]—In the last number of Knowledge, page 450, "Gypsum" questions, on theoretical grounds, my inferences concerning his misdoings in the manufacture of wine. My conclusions concerning the substitution of tartrate by sulphates are not theoretical, but are proved by the analysis of many eminent chemists. All are unanimous on this point. "Gypsum" says that "if this were the result of mixing sulphate of lime and bitartrate of potash in wine, the same result would ensue if bitartrate of potash were added to hard water." An action corresponding to that which I described does take place. Everybody who has used cream of tartar as a beverage, or otherwise tried to dissolve it in hard water, knows that there remains an insoluble residuum from which no more flavour of cream of tartar can be extracted by adding more water. This precipitate is a compound of the tartaric acid with the lime in the water; the potash of the cream of tartar having gone over to the acid with which the lime was originally combined. Cream of tartar dissolves in about 180 parts of cold distilled water, very much less as the water is warmed.

I never attributed the mischievous action of plastered or otherwise cooked sherry to "a trace of gypsum," being well aware that the wine cannot possibly dissolve one-tenth of the quantity of gypsum required to produce the precipitate I obtained from the samples as described, and which any body else may obtain by following my instructions concerning the use of chloride of barium. There was free sulphuric acid in some, alum in others, sulphates in all, substituting the natural organic acids, and organic salts of simply fermented grape juice. The evil results of such substitution, either in food or drink, are too well known to demand any further discussion.

I am not able to fully reply to the query of Mr. Scargill which follows the above, not being able to understand how gypsum can be made "to dissolve freely in water." It requires 400 parts of water for its solution. As stated above, this quantity, either in beer or water, can have but a trivial effect. When I first visited Paris in 1842, the water commonly used was saturated with sulphate of lime. The weather was hot; I drank much of it, and suffered some inconvenience. An English resident-physician then told me that sulphate of lime has the same aperient action as its chemical cousin, sulphate of magnesia (Epsom salts). In order, however, to take a dose of half an ounce, ten pints of saturated water, or a corresponding quantity of saturated wine or beer, must be taken. W. Mattieu Williams.

"STATISTICS OF BARATARIA."

[1526]—Some time ago, the Editor of Knowledge remarked that a man's descendants, after some generations, had but a fraction of his blood in them; and this is repeated and amplified by Mr. Grant Allen on p. 416, Knowledge, vol. vi. It occurred to me that though this is mathematically true, yet there are reasons for thinking it is not physically so. It does not follow that because in the fourth generation a negro's posterity are "white by law," all other peculiarities are lost in other cases—*e.g.*, there may be different results from cross-breeding and from in-and-in breeding. And in his last paragraph Mr. Allen seems rather to modify what he says in the preceding one. "The one certainty upon which the ethnologist can repose is physical peculiarities. These . . . repeat themselves."

How can this be reconciled with (*supra*): "Nobody on earth could possibly detect in the fifth remove the very slightest tinge of negro ancestry"? Why does not an occasional negro turn up in such families, like the lips of the Polish princess in the Hapsburg line?

My belief is that the mothers do little to modify races, but that general physical arrangement follows the patronymic. The Duc de Nemours is the picture of his ancestor, Henri IV. It would be of some value if we could ascertain whether any of his brothers resemble in an equal degree any of their ancestresses.

My attention was fixed on this twenty years ago by a striking circumstance. I knew the names of all my foremothers married to paternal ancestors, up to the beginning of the fourteenth century. My mother was pure English; my father's mother, pure Welsh; his father's, Anglo-Irish; his father's, again, pure English. All before that were pure Lowland Scotch; but my ancestor of the thirteenth century is said to have been Celtic, and for this reason we are reckoned among the Highland clans, though our cradle lies south of the Highland line. In 1863 I made the acquaintance of another branch of our name, absolutely pure Scotch. To my surprise, I found them repeat, not only in general likeness, but in small details, my own near relations. I saw also a fine portrait of my great-grandfather's grand-aunt (of my own name), which was, line for line, that of my own sister, save the forehead. But the most curious thing was that when I entered the room at a meeting of the R.S.A.S., a Fellow remarked to another "What an extraordinary likeness that gentleman bears to the —— of ——" (naming the elder branch of my family, now extinct, whom he had known in youth). How could a mongrel like me be instantly spotted as a scion of a pure Scotch race, unless it be that—at all events, within certain limits of race—the original paternal blood is never washed out; or, at least, not in two hundred years, for it is just that since I had a Scotch ancestress.

As I get old I remind myself, more than of any one else, of my mother-in-law, who was absolutely pure Highland, and not the faintest relation. How can this be, unless I reproduce my last pure Celtic ancestor, who was born certainly not later than 1250? These facts are all the more strange when I add that I am also very like my mother's father.

From the above date I would also draw a political moral. The sovereign of a realm, however limited his powers, must always exercise a very large influence over his people. Now the Prince of Wales will, of course, to a great extent "take after" his august mother. But the *future* kings will repeat, not the line of Guelph, with which we shall be done for ever, but those obscure Dukes of Saxe-Coburg-Gotha, from whom spring the new line of double-German kings.

If we wish to forecast what sort of Royal family we shall have in ages to come, it is these sovereigns whose biographies we should study. Yet there has been, I think, only one book published about them; and it does not seem much sought after. Hallyards.

"EDWIN DROOD" (DICKENS'S STORY LEFT HALF TOLD).

[1527]—I think you have recently expressed yourself as of one mind with Mr. Foster on the subject of "Edwin Drood." Will you, then, allow me to be "H. E.'s" ally in the argument. I may be able to notice one or two things in defence of his theory.

Mr. Foster makes a great point of the sight which so horrified Jasper when he was attacking Edwin on "the great tower." May not this horrifying sight have been merely the ugly result of the sudden and violent strangulation which Edwin was undergoing? Jasper would have good cause to say he had never seen *that* before, whatever else he might have seen "in his mind's eye" when planning the murder.

Mr. Foster suggests that, when Edwin was flung into Mrs. Sapsea's tomb, "the strong silk shawl with which Jasper had intended to throttle him" was drawn over his face. According to this, Edwin

must have stood a strong chance of being smothered as well as throttled.

As to Datchery's resemblance to Edwin (in Mr. Foster's mind) there is great ingenuity, but nothing sufficiently "commonplace" to make the resemblance rational. Would a few months' mental and bodily suffering change Edwin—the thoroughly English Edwin—into a vindictive, calculating avenger? And could he return to Cloisterham, where he had been pretty well known, and assume a very striking disguise of manner, speech, gait, and appearance without expecting shortly to be exposed, and without being so exposed? Mr. Foster seems to make light of the fact that Datchery's personal appearance is calculated to draw marked attention, which attention must have discovered Edwin immediately.

Whereas a detective might happen to have a strange and striking appearance—having reached a certain period of life—without finding it interfere with his watching of Jasper. Indeed, it seems to me that the open and persistent watching of the supposed murderer is a means to frighten confession from his guilty conscience.

Fancy Edwin sauntering about Cloisterham with a large grey wig on!

That Datchery knows the Deputy's name to be "Winks" is not surprising if Datchery is a detective; he may also know the queer names of a good many more persons who frequent the Traveller's Rest. Mr. Foster contends that no one ever speaks of Edwin as *dead*; but then no one *knows* him to be dead. His death is only assumed because his watch and other trinkets have been found, while his body has not. When a person is missing, even under strong presumptive evidence of foul play, or of suicide, his friends long hesitate to speak of him as dead, or to acknowledge the probability of his fate. Rosa's conduct, and the silence of those around her, is an instance of this.

I agree with "H. E." as to the illustrations which Mr. Foster has produced. They prove nothing; for if they represent Edwin's escape from his uncle's attempt on his life, Charles Dickens would not have published them. Fearing—as we now know—that the story was being unfolded too rapidly, would Dickens have assisted his readers by showing at a glance what he would prefer to reserve for several hours' reading? As to Grewgious' manner, it was at no time genial, excepting, perhaps, where Rosa is immediately concerned. Of course, he cannot make up his mind about Landless. He knows him to be a bad-tempered young man, who has savagely quarrelled with Edwin. Of the two persons last seen with Edwin, Landless is proved innocent: suspicion, therefore, is obviously to be fixed on Jasper, and Grewgious, naturally enough, tests that person in a deliberate and open manner. The result of the test in the celebrated interview is that Jasper conclusively proves to his keen opponent that he is the guilty man.

There is no reason why Deputy should not have betrayed Jasper eventually; but if Jasper was betrayed *immediately after the crime had been committed*, he could not possibly have escaped. Before Edwin—under the most favourable circumstances—could have recovered sufficiently to intercede, Jasper would have been pointed out as the would-be murderer, and would be locked up immediately.

Finally, if a murder is supposed to have taken place, how long will the police and the press and the local busybodies permit suspicion to fasten on an innocent man without sifting the matter thoroughly?

Even in Edwin Drood's time public opinion in all its branches was not unknown, and nothing but the knowledge that the police had not forgotten the crime, nor despaired of discovering the criminal, would cause the matter to be so patiently treated by *Landless*.

As to Edwin's reddening (to hark back a moment) when he (see Mr. Foster's theory) heard the opium woman mention his name, would not any man of Datchery's age and build redden when he stooped? J. B.

THE LUNAR ECLIPSE OF OCTOBER 4.

[1528]—May I be allowed to say, in connection with the editorial remark on p. 446, that it was not I, but M. de Boë himself, who calculated the position of the Cordilleras with reference to the earth's limb at the instant illustrated in the diagram in my letter (1451) on p. 325. It never occurred to me to check the results of one whom I knew to be so able a mathematician as my learned Belgian friend. William Noble.

Forest Lodge, Nov. 28, 1884.

NOAH'S RAINBOW.

[1529]—In Mr. Garbett's letter in your issue of June 13 he says: "I never met a Jamaica negro who had seen a rainbow, or had more conception of it than snow." After reading this statement I began asking some Jamaica negroes if they had ever seen a rainbow, and I have been asking ever since without ever once coming across one who was not ready to swear to having seen plenty.

This morning, at 6.30, I saw a complete bow with my own eyes. Now, whom am I to believe? I may add that not even the negro children showed any astonishment at the sight. E. Nankivell.

P.S.—At 2.15 p.m. to-day (Nov. 5) I saw a succession of nearly perfect rainbows.—E.N.

Port Royal, Jamaica, Oct. 27, 1884.

LETTERS RECEIVED AND SHORT ANSWERS.

G. St. Clair. Your pamphlet does not lack ingenuity; but the idea of more than one white is one which I fear 999 of every 1,000 students of physical optics must hopelessly fail to grasp.—Alfred Sanders kindly supplies the information that Darwin's "Biographical Sketch of an Infant" was published in the number of "Mind" for July, 1877.—Isidore. No; "the thought has" *not* "occurred to" me "that if the Electric Light is persisted with and becomes a general illuminant it will eventually bring about darkness and destruction." Whether any of my "brother scientists" have suffered under such an hallucination I am unprepared to say.—E. A. Tindall. There are difficulties in the way of increasing the size of the star maps. With reference to your other criticisms the general plan was decided on after very full consideration. To adhere to a definite scale of magnitudes appeared the only consistent way of proceeding. You will see that the pupil photometer has been received.—P. A. R. Wood is petrified by the infiltration of silica (the base of flint) into its tissues, which are replaced by the mineral, just as in the case of other fossils. This is a process which has gone on at a comparatively recent geological date at or near the earth's surface. Coal has been formed by the bituminous fermentation of vast masses of vegetable matter under great pressure. Peat, cannel coal, Bovey coal, and the like, represent stages in the formation of true coal.—Naturalist. See Maynard's "Manual of Taxidermy," sold by Trübner & Co., reviewed on p. 292 of our last volume.—H. F. A. Young's "Strains on Girders, Arches, and Trusses," published by Macmillans, ought to suit you. See Knowledge Vol. V., p. 482.—Zero. When the moon is on the horizon her angular diameter, as measured with a micrometer, is actually *less* than it is when she is high up in the heavens. If you draw a diagram you will see that under the latter circumstance she is really nearer to the spectator than under the former condition. The whole thing is an optical illusion. In the open vault of the sky you have nothing to compare the moon with. When she is on the horizon you have, as a rule, numerous objects of known size in juxtaposition with her. A balloon affords just the same illusion. It looks a very little thing as it goes overhead, but an enormous object as it approaches the earth; albeit it may descend at a considerably greater linear distance.—J. Gillespie. Read any elementary work on physical geography. Did it ever occur to you that the melting of the snow on the equatorial ranges of hills near the source of the Nile had anything to do with its rise?—A Reader of "Knowledge." The (inappropriately) so-called "Harvest-Moon" is the full moon which happens the nearest to September 21st, and this can obviously never occur in August. Whenever the moon is pretty close to the first point of Aries, which, of course, is the case during part of every lunation, she rises on each of two or three nights running a very little later than she did on the previous one. No one notices this when she is a crescent, but when she is full it becomes more striking. Now she is only full in Pisces and Aries at the time of the autumnal equinox; hence the harvest-moon.—W. H. Greene. Shall receive immediate attention.—S. J. H. I regret that you should have had the trouble of sending an answer to Letter 1398 all the way from India, when I have already excluded some quires of replies from English correspondents.—W. Aston. The projection of a solar eclipse is very much too complicated and operose a matter to be popularly explained, and would occupy considerably more space than can be spared. Moreover, unlike an eclipse of the moon, it must be calculated separately for every fresh station.—Bird-Stuffer. A design for sticking 2,000 postage-stamps on to a fire-screen is more in the way of *Myra's Journal* than in that of a professedly scientific periodical like Knowledge.—L. A. W. If the rays round the star disappear after a little gazing, the fault is obviously in your own eye, and not in the object-glass at all; but, as you describe the image as only "tolerably clear" after all, the objective may be faulty too. Too low a power gives indifferent and glaring images of stars. Nothing surpasses the admirable "Celestial Objects for Common Telescopes" of the Rev. Prebendary Webb as a catalogue of all interesting objects. Neptune is in a very blank region of the sky just now. The only direction I can give you for finding him by means of "The Stars in their Seasons" is to refer you to Map I. of that work. On this you must draw a line joining δ Arietis and 5 Tauri, find the middle of it, and fish

with the telescope in the sky to the right of this middle point for the planet. I may add that you will wholly fail to distinguish him from a small, dull, fixed star with a 2·1-inch telescope.—W. JEROME HARRISON. Both received; to appear in due course. I fear that it will be some time ere we shall have room for a description of the gelatine plate process.—DAVID HOUSTON. Accepted with thanks.—W. R. SCANLAN. The conductor of KNOWLEDGE is not at present in England. An answer which applies equally to J. B. HODGKIN and to E. SMYTH. Will the two latter correspondents be good enough to read the italicised paragraph which is printed at the end of these "Answers?"—W. M. You may take it that the point at which the eye will be placed must be 200 miles from either of the stations midway between which it is situated; and a line from it to either of such stations will be a tangent to the earth. Regarding the earth as a sphere with a mean radius of 3,956 miles, we have a triangle right-angled at the station, with the base 3,956 miles long, and the perpendicular 200 miles long; so that we have only to square 3,956 and 200, and, after adding the squares of these together, extract the square root of their sum, to get the length of their hypothenuse, from which, if we subtract the earth's radius, the remainder will be the height of the eye above the surface of the earth (Euclid I. 47).—A. Fanatics always have, and always will continue to, abuse those who differ from them. Deadly as alcohol is to individuals, the alcohol-consuming races have come prominently to the front in life's struggle, and have conquered all the world. There was more in what you complain of than met the eye. You are entirely right as to testimonials. My private impression is that the person to whom you refer is not responsible for his actions. Certainly, for his own sake, I hope so. I unfortunately cannot read Spanish.—S. O. See note on p. 439. Under any circumstances, such reproduction will not occur during the present year.—G. H. L. The list of constellations following the maps on pp. 424 and 425 is a complete one, comprising all those visible in England. Only a portion of these can be seen at once, and those which can be so seen vary with the time of year. During the November and December nights, No. 9, to which you specially refer, is far below our horizon. Scientific astronomers of all nations use the Latin names of the constellations; but, of course, their popular names vary in different parts of the Continent. As a rule, however, they are simply translations of the Latin originals.—R. TUDSBURY AND SONS. Delayed through being addressed to the Editor, instead of to the Publishers.—BELIEVER. Look through the list of publications issued by the Messrs. Clowes & Sons in connection with the International Health Exhibition. You will find all you need there.—E. MAYO. See KNOWLEDGE, Vol. III. p. 262. Probably "The Universe of Stars" would furnish the information you require. Note the concluding paragraph (in capital letters) which heads the correspondence column.—MATTHEW C. OATFIELD. See paragraph at the bottom of column one, p. 62, of the current volume.—D. VILLIAMS. Many thanks; but mere observations are numerous and not of great interest. Some of your *results*, though, as you will see, have been embodied in a short article. Your contrivance for viewing Solar spots is a familiar one. *Vide* "Elementary Astronomy," published by Cassells, p. 136, and p. 22 of Webb's "Celestial Objects for Common Telescopes," &c.

In reply to numerous letters and communications addressed to the office of KNOWLEDGE, *its Editor begs to announce that he has concluded his Lecturing Tour, and has, in fact, definitely ceased to lecture altogether. Should he (which is very doubtful) at any future time resume his lectures on Astronomy, due and ample notice will be given of such resumption in these columns.*

Our Whist Column.

BY FIVE OF CLUBS.

DISCARDING.

FEW points of whist play are more important (and, it might be added, few are more neglected) than the discard. An original discard is like an original lead in its significance; a forced discard has a meaning akin to that of a forced lead; it is as important to distinguish a forced from an original discard as to avoid mistaking a lead from weakness for a lead from strength; and finally, to discard properly at the close of a hand often requires as much skill as the art of rightly placing the lead at that stage of the game.

When you have to discard to the first suit led, that suit being plain, and no indication having been given of trump strength anywhere, your course is simple. If the plain suit is your partner's, you discard from your shortest suit, unless in so doing you have to unguard a King or Queen, when—unless you are very strong in trumps—it is better to discard from the suit which needs least protection: though of course you would unguard a King or Queen unhesitatingly, rather than injure a long and strong suit of your own. If the suit (plain) which you first fail in is your adversary's, you equally discard from your shortest suit, in general; but to the exceptions just noted may be added (i.) the case where you have to leave an Ace single, and (ii.) the case of your shortest suit being a singleton. For when an adversary's suit has been exhausted, your weakest suit is likely to be your partner's best, and it may be a matter of great importance later to give him a lead in it. But if your own suit is strong as well as long, and you are fairly strong in trumps, you may more safely uncover an Ace or discard a singleton, for the close of the hand is more likely to be under *your* control than under your partner's. You must weigh the chances, and take your chance, just as you have to do when forced to lead from a weak suit without knowledge how your partner stands in it.

When trump strength has been disclosed, either by the signal or by a lead, before the occasion comes for a discard, or when you have to discard to trumps, the general rule is, discard from your weakest suit if trump strength lies, or appears to lie, with you and your partner, from your longest and best protected suit when trump strength lies or appears to lie with the adversaries. (But so long as there is a chance of bringing in your long suit, you should not discard from it.) While doubt remains as to the position of trump strength, avoid unguarding King or Queen, uncovering an Ace, or discarding a singleton; but when it is certain that your partner has commanding strength in trumps you need be less careful on these points, for there is little fear but that your partner will get the lead when he wants it. Albeit, cases sometimes arise where your long suit is worthless, and so much manifestly depends on your giving your partner a lead, or keeping guarded a strong card in his suit, that you must discard (even originally) from your long suit. Suppose for instance the first two rounds have shown that Clubs and Diamonds are the best suits of the enemy, and that then the fall of trumps (led by your partner) shows that you and he will remain with a long trump (a Spade) each, the first lead outside trumps coming from your partner: then if you hold Ace, or King, or Queen of Hearts and a small one, along with weak Clubs and Diamonds (of which you originally held three and four, respectively), it would be absurd to follow the usual rule and discard your small Heart: for thereby you lose the chance of taking the first round in Hearts and returning your partner the suit, or of helping to clear his suit in the first round, ruffing Clubs (having discarded in that, your second shortest plain suit) and then returning Hearts. Common sense must guide you in such cases.

Remember, however, as a general rule for learners, that your original discard indicates your shortest suit if trump strength is not declared against you, your longest suit if it is. Subsequent discards have no such significance. One of the most important points in Whist training, is to learn to notice the original discard of each player as carefully as you should notice his lead. Until you do this you cannot properly be said to play Whist at all.

In the later rounds of a hand the question of the discard assumes an entirely different aspect, just as does the question of the lead. You have to consider what suit the enemy threaten to bring in, so that if you have command in that suit you may retain it religiously; and to note what suit, if any, your partner may bring in, so that if you have the command in that suit, in such sort as to be likely to obstruct him, you may give it up by discarding your commanding cards.

"How to Play Whist," by "Five of Clubs," is now in the press. It will be published, as a volume of the "KNOWLEDGE Library Series," in a few days. It contains chapters on the Lead, Play Second, Third, and Fourth in Hand, Returning Partner's Lead, the General Conduct of the Hand, How to Play Trumps, the Discard, Signalling, and the Last Tricks. Forty Illustrative Games follow, each fully annotated (as in KNOWLEDGE). This is a new feature, the games in Cavendish being only annotated, and that slightly, from the point of view of one player. Then comes a section called Whist Whittling, containing notes, stories, cuttings, problems, and so forth. And the work closes with the Laws of Whist, Whist Etiquette, a Glossary, and Solutions of Problems.

Our Chess Column.

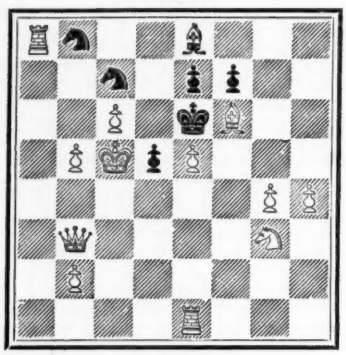
By Mephisto.

PUZZLE No. 139.

By Zukertort.

(From the *Bradford Observer and Budget*.)

Black.



White.

White to play and mate in two moves.

THE EVANS GAMBIT.

(Compromised Defence.)

(*Continued from p.* 394.)

1. P to K4, P to K4. 2. Kt to KB3, Kt to QB3. 3. B to B4, B to B4. 4. P to QKt4, B × P. 5. P to B3. In our former articles we have examined Black's reply of B to B4, which is safe to play, as it limits the number of attacking moves at White's disposal. We shall now proceed to discuss Black's reply of

5. B to R4

which move requires greater care on the part of the defendant player.

6. P to Q4 — P × P
7. Castles — P × P

This is the compromised defence, which Zukertort and other analysts pronounce to be sound. We shall hereafter proceed with other variations arising from 5. B to R4. The usual continuation of the compromised defence is

8. Q to Kt3 — Q to B3
9. P to K5

Kt × P would not be good, on account of 10. R to K sq., P to Q3. 11. Q to R4 (ch), K to B sq. 12. Kt × Kt, P to B7. 13. Kt to Kt6 (ch) and mate.

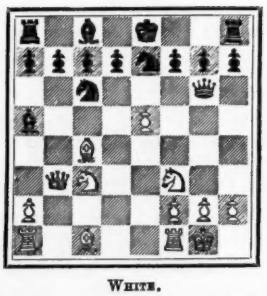
Q to Kt3.

10. Kt × P

Here B × Kt would lead to the following:—11. Q × B, KKt to K2. 12. Kt to Kt5, Castles. 13. B to Q3 with advantage.

KKt to K2

Black.



White.

This is a usual position in this defence. White has now two good moves at his disposal for continuing the attack, one is 11. Kt to K2, and the other 11. B to R3. We must confess to a strong liking for B to R3 in the Evans Gambit. The attacks arising from both lines of play are very interesting.

11. Kt to K2 — P to Kt4
(This move is considered best for the defence.)
12. B to Q3 — Q to K3
13. Q to Kt2 — Kt to Kt3
14. Kt to B4 — Kt × Kt
15. B × Kt — P to KR3
16. QR to B sq. — P to R3
17. KR to Q sq. — B to Kt2
18. Q to Kt sq. — R to Q sq.
(With a defensive position.)

On the 13th move White may also play—

13. Q to Kt sq. — Kt to Kt3
14. B to Kt2 — B to Kt2
15. P to QR4 — P to Kt5
16. Kt to Kt3 — Castles QR
17. R to B sq. — Kt to B5
18. B to K4 — P to KR3
19. P to R3

In illustration of the move of 11. B to R3, we give the opening moves of games recently played, *vide* diagram of position:—

	Zukertort v. Hirschfeld.		Hirschfeld v. Mason.		Zukertort v. Hirschfeld.
11.	B to R3	11.	B to R3	11.	B to R3
	Castles		Castles		Castles
12.	QR to Q sq.	12.	QR to Q sq.	12.	Kt to K2 (*c*)
	P to Kt4		B × Kt (*b*)		P to Kt4
13.	B to Q3	13.	Q × B	13.	B to Q3
	Q to R4		P to Q4		Q to K3 (*d*)
14.	Kt to K4	14.	P × P (en pas)	14.	B × P (ch)
	K to R sq. (*a*)		P × P		K to R sq.
15.	Kt to B6	15.	R × P	15.	Q to K3
	P × Kt		B to K3		Q to R3
16.	P × P	16.	R to K sq.	16.	Kt to Kt5
	P to Q3		Q to R4		B to Kt2
17.	P × Kt	17.	B × B	17.	QR to Q sq.
	Kt × P		P × B		QR to Q sq.
18.	B to Kt2 (ch)	18.	QR × P	18.	B to K4
	P to B3		Kt to Q4		P to Q4
19.	B to K4	19.	Q to Kt3	19.	P × P (en pas)
	R to QKt sq.		R × Kt		P × P
20.	Kt to Q4	20.	Q × R	20.	Q to KKt3
	P to QB4				B to B2
	with a good defence.		with the better game.		White has a strong game.

NOTES.

(*a*) Zukertort thinks R to K sq. better.
(*b*) The "Chess Monthly" condemns this exchange, considering the KB necessary for the defence and to prevent R to K sq.
(*c*) Not so good as QR to Q sq.
(*d*) Here Zukertort prefers Q to Kt5. 14. P to R3, Q to QR5.

Correction.—In the game given on p. 414, we have reversed the names of the players, which should read: White, R. M. Macmaster; Black, R. K. Leather.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

A correspondent informs us that Grimshaw has composed the first Problem in which a Rook makes room for a Q. The problem was likewise unsound. It was published in Knowledge March 9th, 1883, Vol. III. Correct solutions received from J. K. Milne, W., H. W. Sherrard, Scribbler, F. Champ.

C. Planck.—Thanks; the three-move published last Saturday. Other Problem not clear where the mate comes in after 2K × Kt.

Contents of No. 161.

	Page
Our Two Brains. By Richard A. Proctor	435
Rambles with a Hammer. III. By W. Jerome Harrison, F.G.S.	436
Dreams. (*Conclusion.*) By Edward Clodd	438
Dickens's Story left Half Told	439
Optical Recreations. (*Illus.*) By F.R.A.S.	440
Electro-Plating. XIV. By W. Slingo	442
American Forest Fires	443
A Total Lunar Eclipse. (*Illus.*) By R. A. Proctor	443
Chapters on Modern Domestic Economy. III. (*Illus.*)	446
Other Worlds than Ours. By M. de Fontenelle. With Notes by R. A. Proctor	447
Reviews	448
Face of the Sky. By F.R.A.S.	450
Correspondence: Doctoring Wine —Is Gypsum in Beer Injurious? —Prevision in a Dream — No Matter!—Children's Dress, &c.	450
Our Inventors' Column	453
Our Chess Column	454